Vehicle-to-Water (V2W) Concept for Disaster Relief to Ensure Safe Access to Freshwater and Electricity—A Proposed System Where Electric Vehicles Power the Desalination Process

Jennifer Leijon 1,* and Olof Lindahl 2

1 Division of Electricity, Department of Electrical Engineering, Uppsala University, Box 65, 751 05 Uppsala, Sweden
2 Department of Business Studies, Uppsala University, 751 20 Uppsala, Sweden; olof.lindahl@fek.uu.se
* Correspondence: jennifer.leijon@angstrom.uu.se

Abstract: In this paper, the concept of vehicle-to-water is proposed for disaster relief. This, along with a presentation of a new system including an electric vehicle of van type, with roof-mounted solar panels and a desalination system installed in its cargo hold. The system can be used for transportation and water and electricity supply, with zero tailpipe emissions. The mobile electric vehicle and desalination system are expected to be beneficial for communities with an urgent need for freshwater while also lacking electricity, such as during natural disasters or societal crises in coastal regions. It is related to the water–energy nexus and is an interdisciplinary project. The electric vehicle would have to be charged from a grid-connected charging infrastructure, and the desalination system would require an inlet of seawater and would generate freshwater and brine. The presentation of the innovative system is followed by a brief case study, estimating the amount of freshwater that could be generated and the amount of people that could benefit from such a system. It is estimated that one system could produce up to 29,333 L of freshwater daily, suggesting that around 1466 people could fulfill their personal daily freshwater need of 20 L during a disaster.

Keywords: reverse osmosis desalination; vehicle-to-grid; electric vehicles; water–energy nexus

1. Introduction

Reliable access to clean, drinkable water is an essential part of our society today, which some of us may take for granted. In addition, many of us are also relying on continuous access to electricity. The United Nations Agenda 2030 for sustainable development specifies the societal need for clean water and sustainable access to electricity for all people in two of the 17 goals, namely: “Goal 6: Ensure access to water and sanitation for all” (www.un.org/sustainabledevelopment/water-and-sanitation/ (Accessed: 29 June 2021)), and “Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all” (www.un.org/sustainabledevelopment/energy/ (Accessed: 4 October 2021)) [1]. The combination and interconnection of these goals are known as the water–energy nexus or water–energy–food (WEF) nexus [2–4], supporting ideas that issues related to water and energy systems should be solved together. This is the basis for the proposed system presented in this paper, requiring an interdisciplinary approach, combining the energy system of an electrified vehicle with the energy need of a water system to fulfill human freshwater needs. A recent review on the water–energy nexus was presented in [5]. In [6], a case study of the water–energy nexus in Chile was presented. Moreover, an analysis of the water–energy nexus in Sao Paulo, Brazil, was conducted in [7]. The water–energy nexus was considered for a desalination project in China, presented in [8]. Collaboration over national boundaries when it comes to the water–energy nexus was discussed in [9] for Jordan, including discussions on, for example, desalination plants.
1.1. Desalination

Remote arid regions can face a lack of freshwater during parts of the year, limiting access to clean water for drinking, household activities, and agriculture. Islands can be specifically vulnerable when it comes to safe access to freshwater. Moreover, the water and energy resources on islands are often interlinked [10]. In times where both the droughts and floods are expected to increase, access to clean water could be limited. During natural disasters and societal crises, the access to water and energy may become restricted at a specific location in a short time-period. If the area is located near the sea, desalination of saline water is a highly interesting alternative to ensure a secure access to drinkable water. Many desalination plants are stationary and located where there is a constant need of more drinkable water. Desalination plants input brackish water or saline water into the system and thereafter take away the salt, resulting in brine, separating and saving the freshwater for agricultural or household uses. While desalination projects often dismiss the brine, studies on the opportunity of finding minerals in the brine have been conducted in recent years, such as extracting lithium for batteries for the electric car industry [11]. Desalination, such as reverse osmosis (RO), relies on a significant amount of energy to function. Some debated issues related to RO desalination are the energy need of the process and the management of the high salinity brine [12]. In many cases, fossil fuels are used for powering desalination systems. However, with goals towards more renewable energy sources (RES) and less or no CO₂-emissions, the interest in using fossil fuels for desalination has decreased [13]. Thus, more RES would be used for powering desalination plants to limit the emissions, e.g., wind powered desalination [14] and solar powered desalination [15]. Such systems could include battery storage [13]. To summarize, most of the studies on RES powered desalination include wind and/or solar power, such as a recent study [16]. Moreover, offshore energy systems could be used for desalination, such as wave powered desalination [17,18] or tidal energy or marine current power for desalination [19]. While the RO system produces freshwater in a reliant and continuous manner with a stable and continuous power source, such as the power grid, the RO process can generate freshwater even though the power varies slightly, meaning that an intermittent RES could be suitable for direct drive of an RO process. In addition, the brine management should be designed to not damage the marine environment and potentially also contribute with valuable minerals found in the sea [20]. However, the variability from the RES can cause stability issues when it comes to safe access to freshwater generated from the desalination system. Remote locations with freshwater shortage may have unreliable power grids locally or energy systems based on fossil fuels. Moreover, power grids could be damaged in a critical situation, such as during a natural or societal crises.

1.2. Electric Vehicles and Vehicle-to-Grid

Meanwhile, the transition from using fossil fuels to using more electricity is shown in several parts of society. Generally, the electrification in society is expected to create new jobs and businesses, with the need for more educated people to be prepared to work in the energy sector [21]. The trend of electrification can be seen not least in the transportation sector. Thus, electric vehicles (EVs) with batteries are increasingly common. While there is a strong trend towards more electrified systems today, there is also a current trend towards digitalization. This too would affect the transportation sector. In the future, there may be an increased amount of self-driving autonomous electric vehicles (AEV), requiring little or no steering from the driver. Today, the most common type of EV is the electrified car, and many other modes of transportation are electrified as well. Thus, this requires different types of available and secure charging infrastructure, adapted to the specific requirements of the vehicle. There are several benefits in using EVs, instead of vehicles with internal combustion engine (ICE) systems. The EVs do not use fossil fuels; they are less noisy, and they are overall more environment friendly. Legislations and goals in many countries may cause a rapid decrease in ICE vehicles and an increase in EVs as well as in
a corresponding increased need for charging infrastructure. Previous use of the EV battery for discharging to another system has been presented in the literature. For example, vehicle-to-grid (V2G) has been discussed in several previous scientific papers e.g., [22–29]. Other related concepts previously presented, including discharge of electricity from the EV battery, are vehicle-to-subway (V2S) [30], vehicle-to-home (V2H), vehicle-to-pedestrian (V2P), and vehicle-to-infrastructure (V2I) or, at large scale, vehicle-to-everything (V2X) [31]. While EVs could be charged from the main electric grid [32], the literature also suggests charging from off-grid solutions, including, for example, parking lots with EV charging utilizing photovoltaics (PV) [33]. The new EVs with discharging capabilities and opportunities for charging with only RES open to innovative, flexible, and mobile technical systems that could support society in several ways. This, while supporting goals towards a more sustainable society.

1.3. Aim of This Study

In this paper, vehicle-to-water (V2W) is proposed, where the electric vehicles, charged at one location, could help with powering the water systems at another location. The concept V2W is here defined as technical systems that include one or more EVs supporting one or more water systems, such as desalination plants, with the energy needed by discharge from the vehicle battery and from roof-mounted solar panels, as well as including means for transporting the water. Here, small-scale, portable, RO desalination systems, installed inside a vehicle, are proposed, powered by discharging the EV batteries in times of need. This idea is investigated with an initial brief case study, where the car battery is mainly used to generate freshwater from the RO desalination system. There is an interest in combined water–energy systems, and desalination vehicles have been proposed before, i.e., the Galmobile (www.indiatoday.in/india/story/from-israel-to-india-a-desalination-vehicle-1146142-2018-01-15 (Accessed 22 June 2021)). In addition, EV manufacturers have been part of projects on the energy need of stationary desalination plants (www.pv-magazine.com/2020/02/06/a-new-solar-desalination-system-to-address-water-scarcity/ (Accessed: 1 September 2021)). Moreover, stationary desalination plants, RES, and EVs with V2G in a microgrid for an island have been proposed [34]. However, to the best of our knowledge, the use of EVs, PV panels, and RO desalination in a combined mobile system has not been proposed before. The aim of this study is therefore to present the V2W concept, the EV with portable desalination system for water production, and the first estimations of water production from the system. To give a concrete example of where the trends apply, Norway and Sweden can serve as examples. The water–energy nexus and the electrification and digitalization of the transportation sector can be seen in the Nordic countries. In Sweden, for example, there is a lot of available freshwater for drinking and agriculture. However, parts of Sweden are sometimes, and mainly during the summer, lacking freshwater, with the Swedish island Gotland as an example of a location with water shortage during parts of recent summers. There have been desalination plants installed on Gotland to contribute to the seasonal water shortage. Furthermore, Nordic countries, such as Norway and Sweden, have investigated in more electricity from RES. In addition, the goal towards an increased number of electrified vehicles is seen in Nordic countries, such as in Norway and Sweden, where the charging infrastructure has been expanded as well. The goal in Sweden is not only to electrify personal cars but also the aviation, and there are both plans and ongoing projects investigating an increased number of electric vehicles and the charging infrastructure needed for these, such as for charging of the future electric airplanes at the airports. Meanwhile, there is an increased concern in, for example, Sweden regarding which kind of effects fossil fuels could have on our environment and how they could affect our climate, and if the future could include more natural crises. As such, systems increasing the preparedness in the case of an unlikely event of societal or natural crisis could be interesting to start designing beforehand.
2. Proposed Mobile Water System

2.1. System Overview

The system that is proposed in the following is suggested as support in the event of a crisis, i.e., for disaster relief. A van-type EV, with battery storage and solar cells on the vehicle roof, is proposed. A small portable RO desalination system is installed inside the van. The RO system would require an inlet of saline water and will generate freshwater out from the system, as well as brine with high salinity. An illustration of the proposed system is shown in Figure 1. This would be a mobile desalination system, which could be charged with the PVs if necessary but also with the use of grid-connected charging infrastructure where available. Apart from powering the propulsion of the electric van, the battery and the solar panel could also power the desalination system to generate freshwater in situations where both power and water supply have been disrupted. In addition, disaster scenarios of the magnitude discussed here can also be expected to disrupt fuel deliveries, making electric propulsion from independent sources particularly valuable.

![Figure 1. An electric van with AC or DC charging, solar panels on the roof generating DC, and an RO desalination system inside for a mobile freshwater production system. Inlet of saline water and outlet of freshwater and brine are shown in the sketch.](image)

An additional trailer, carrying water storage tanks, can be connected to the EV. Tanks could also be included inside the van, space permitting. The tanks can be filled up with freshwater from the desalination system at the coast and then transported to the location where the drinking water is needed the most. This could be beneficial if the coastal area, with available saline or brackish water, is further from the place where the water is needed the most, such as where a natural disaster, severe droughts, or power-outs have occurred. The system for disaster relief could also be installed on an electric boat, which would simplify the in- and outtake of saline water, but this further complicates the delivery of freshwater to other than immediately coastal locations. The main benefit of the proposed system is to create a mobile and self-sustained unit applicable for disaster relief, where there is a rapid need of more freshwater and electricity. Converters are necessary as the desalination system may utilize AC power, whereas the power out from the batteries of the vehicle is DC, and the power produced from the solar panel is DC. The vehicle would, if possible, be charged by AC or DC power from the nearest secure grid and available charging infrastructure. However, during a disaster, the grid and charging stations nearby could be down completely or during several hours. The charging with a cable could be changed to, for example, charging via battery swapping [35], if it could be faster and...
locally more suitable. In the future, there could also be other ways of charging EVs, such as utilizing inductive wireless charging.

2.2. RO Desalination System

The portable RO system that could be installed in the EV could for example be purchased from the manufacturer Rainman [36], and a sketch of such a small potable RO system is shown in Figure 2. The RO desalination system includes two RO membranes, each with a length of about 1 m, connected to a motor, a pump, and a prefilter. The system includes a lift pump to pump in saline water to the desalination system, through an intake hose that is placed in the saline water. As the pressure is increased on the RO system, it will result in separating freshwater and brine. This Rainman portable desalination system can produce up to around 140 L per hour, according to the manual [36], which in total is 3360 L per day during full production rate.

Figure 2. Sketch of the portable RO desalination system from Rainman desalination inside the electric van, including the two RO membranes, the motor, and the pump.

3. Case Study of V2W Concept

In the following, estimations of the amount of freshwater production from EVs with RO systems and PV panels are presented. An RO system for seawater desalination can be estimated to utilize about $ERO = 3 \text{ kWh per cubic meter clean water produced}$ [37,38], but this energy need varies with the specific design and size of the desalination system, the salinity of the inlet water, etc. In a similar manner, the energy stored in an EV varies, with the specific vehicle type, state of charge-value (SOC), etc. As an estimation for this case study, the van battery stores $EVAN = 90 \text{ kWh}$. The size of the EV trunk depends on the chosen EV model and can be adapted to the size of the desalination system, and it is estimated that the cargo space is around 4 $m^3$. Moreover, the weight that the vehicle can be loaded with may vary with the EV model, but it is here assumed to be at least 700 kg. It is estimated here that the energy needed for driving a certain range is $EDRIVE = 30 \text{ kWh/100 km}$. In the following, it is assumed that the vehicle is fully charged with $EVAN$ and that the vehicle would be driven $D = 10 \text{ km}$ to and from the area where the water is needed, such as to and from the disaster area, suggesting it would require $ED = 3 \text{ kWh}$ for the trip. Furthermore, in the following, it is assumed that the solar panel has the rated value of $PPV = 250 \text{ W}$, and the size of one panel is $1.63 \text{ m}^2$ [39], and it is assumed to generate power for about 4 h each day (depending on the site where it is used), resulting in $EPV = 1 \text{ kWh}$ each day, to recharge the battery or for another purpose, such as charging a mobile phone,
again, noting that the power production over a day varies with the design of the system, location, weather, etc. The amount of freshwater produced \( F_{\text{PROD}} \) \( [\text{m}^3] \) from one vehicle could be estimated by

\[
F_{\text{PROD}} = \frac{(E_{\text{VAN}} - E_{\text{D}} + E_{\text{PV}})}{E_{\text{RO}}}. \tag{1}
\]

As noted, all values of the three parts of the proposed system (i.e., PV panel, van, and RO system) vary and are set to estimated values for this initial case study. One vehicle or several vehicles could be used for disaster resilience, to generate the amount of water needed for the specific situation. There are limitations to this study as it is built on calculations with estimated input values, and not experiments. Moreover, energy or water losses from different parts of the system have not been considered in the rough estimations in this paper. The estimations are divided in cases with (i) one vehicle, (ii) several vehicles, and (iii) one small city, where people are in sudden need of more freshwater. Different scenarios, such as the following three scenarios, can be assumed for a disaster where the inhabitants need more drinkable water rapidly, where EV charging from the grid is more or less available nearby the disaster area. In scenario 1, there is no available grid at the site of the disaster. In such cases, the PV system, as well as the battery capacity, could be expanded to enhance the autonomy of the vehicle. In scenario 2, there is intermittent access to electricity due to sudden power outages or only power available during certain hours. At these times, the EV could be charged fully or partly when there is available power, and the desalination system could be powered directly from the grid when available. In scenario 3, there is access to charging of EV in a certain distance from the location of the disaster. The EV would firstly be charged from the grid, then driven to the location where the water is needed, and finally driven back to the charging station. The longer the EV must drive, the less power is available for the desalination or charging of other equipment. In cases of disasters, it is noted that there could be a shortage or unreliable access to both water and electricity simultaneously. Note that the estimations and case studies are initial rough estimations for the system and based on several assumptions.

4. Results of Case Study

4.1. One Vehicle

4.1.1. One Vehicle with RO System

Utilizing the estimated input values into Equation (1), the amount of water produced from a fully charged vehicle with an RO system and distance driven would be about

\[
F_{\text{PROD}} = \frac{(90 \text{ kWh} - 3 \text{ kWh} + 1 \text{ kWh})}{3 \text{ kWh}/\text{m}^3} = 29.333 \text{ m}^3. \tag{2}
\]

This suggests that for one day, the van can drive 10 km and produce up to 29,333 L. If one person would use 20 L of water for basic water access [40], 1466 people could benefit from the system. The efficiency of the RO system affects the amount of water produced per day from the vehicle, and assuming, that the energy needed of the RO system, \( E_{\text{RO}} \), varies from 2.5 kWh/m³ up to 5 kWh/m³, the amount of people that could benefit from one vehicle (assuming a daily need of 20 L) is shown in Figure 3.
Figure 3. If the energy needed of the RO system for producing one cubic meter freshwater would vary (kWh/m³), this affects the amount of people that could gain 20 L freshwater from one EV system.

Moreover, the amount of energy stored in the battery of the EV affects how many people that could benefit from the system, as shown in Figure 4, for a battery storage of 60 kWh up to 110 kWh for one vehicle and shown for different energy needs of the RO system (from 2.5 to 5 kWh/m³). This is an example where the desalination system inside the vehicle is not limited in how much it can produce each day due to its size.

Figure 4. The energy storage of one EV affects the number of people that could benefit from an RO system installed in it, if 20 L freshwater per person each day is assumed, and this varies for different energy needs of the RO system (kWh/m³).
4.1.2. One Vehicle and Several Rainman RO Units

Noting from Equation (2) that the estimated water production from one EV van is lower than the maximum estimated production rate of a Rainman portable system (i.e., around 3360 L daily), one vehicle would be able to be driven 10 km and produce freshwater, as much as the Rainman desalination system can, with the battery capacity of the vehicle. This, even if the vehicle is not fully charged at start. Several Rainman systems could be installed in the same van if there is available size for the installation. It is assumed in the following that one portable RO system weighs about 35 kg (www.rainmandesal.com/acelectric-watermaker/ (Accessed: 1 September 2021)). If around nine Rainman desalination systems were installed in the van (29,333 L/3360 L/system), the maximum amount of around 29,333 L produced daily could be estimated from the V2W system, assuming full freshwater production over the day (i.e., with a production rate according to the manual, as presented in Section 2.2) and the assumed power available from the vehicle. Thus, including several small portable desalination systems or installing larger desalination systems in the van could be beneficial for producing more freshwater.

4.2. Several Vehicles

Assuming that several vehicles are used, with the input values presented in Equation (2), the amount of people that could benefit from the system and receive about 20 L increases, is shown in Figure 5. For around 30 EVs, the system could provide clean water (here 20 L per person and day) to above 40,000 people daily.

![Figure 5](image)

**Figure 5.** Assuming that several EVs with RO systems are used, the amount of people that could gain 20 L of freshwater from the vehicles is estimated.

4.3. One Small City

In the event of natural or societal crises, the inhabitants of a city may need more drinkable water at the same time. The proposed system is scalable to meet an increased demand of drinking water by many people. In a crisis, the water demand per person could be 20 L daily (0.02 m$^3$/day), noting that in normal times, the water demand would be higher. Thus, for a population of 10,000 people, the water demand during a crisis could be 200 m$^3$/day. A fleet of around seven electric vans, fully charged and equipped with large desalination systems (equal to about nine portable Rainman RO systems), is
assumed. Each van would produce approximately up to 29,333 L of freshwater each day if utilized at all hours, and all seven EVs would produce the basic water needed for 10,000 people. The amount of water produced by the fleet is, for example, limited by the driving range expected for the vehicles, the initial SOC of the battery, the size of the desalination system installed in the limited size of the van, and, potentially, the access to water storage units. Thus, a rather small EV fleet could, according to this first estimation, benefit thousands of people with the water needed daily for human survival.

5. Discussion

The estimations suggest that EVs with installed desalination systems could significantly contribute to freshwater production beneficial for human use during urgent need. This, with no fossil fuels needed for either the car or the desalination system, allows for a mobile quiet system that is more or less self-sustainable in terms of the energy required to operate. The amount of people that could receive 20 L of water each day is greatly affected by the performance of the different parts of the system, such as the energy need of the RO system, as shown in Figure 3. In addition, how the EV is designed also affects the amount of water that could be produced and especially the battery size and how much it is charged initially, as shown in Figure 4. These results further support the idea that water and energy related questions should be solved together in interdisciplinary projects. If several RO systems are installed in the same vehicle, as suggested in Section 4.1.2, the EV should be able to carry the additional weight of the RO systems, as well as have enough available space for installation of the system. While several small portable RO systems could be used, it may be more feasible to install one larger RO system in the van and complement the EV with a cart including a water storage tank. This, to be able to transport the freshwater to where it is needed. Moreover, the desalination system would require an inlet of seawater or brackish water. In addition, to ensure a significant water demand during a specific event such as a natural disaster, where many people suddenly need more drinkable water, only one equipped EV may not be enough. Here, the concept of V2W is suggested, but in the future, other types of ideas on how to use the bidirectional power flow from EVs could emerge. The cost of the system could be analyzed in more depth in future studies, but it is assumed to include the costs of purchasing the vehicles, the RO systems, the PV panels, charging costs of the vehicle, installation costs of the full system inside the vehicle, costs for the driver, frequent maintenance of the RO system and maintenance of the vehicle when needed, etc. A future EV for the purpose of water-energy supply may be fully autonomous so as to not put a driver at risk if the vehicle is to be driven into a region of natural disasters or a war zone where the demand for water and electricity is severe. Moreover, without the driver, there is no need to stop the driving for sleep or food, etc. The AEV would need to be controlled to be charged at the nearest charging station when the energy in the battery is too low. The increased digitalization of the vehicles, such as AEVs, could result in issues regarding legislation in different countries and issues regarding cybersecurity aspects. Moreover, if there is no driver, the users of the water system need to be informed by clear instructions on how to start the desalination system, including arranging the intake of saline water by the RO system. The charging of the vehicle will also be managed without the driver if it is an AEV. A mobile team of doctors could benefit from the V2W system if they are going to a location where they are not certain about the amount of freshwater available or the availability of a stable grid to power medical equipment. In addition, the vehicle could be redesigned with systems for water, sanitation, and hygiene (WASH), which could be lacking in some parts of the world and especially during disasters. Future work on the proposed system could include further investigations of opportunities for new business models when it comes to electromobility and access to both water and electricity. The solar panels can be taken down from the vehicle and mounted once the vehicle has entered the site. This proposes that the vehicle would not attract too much attention while entering the location where the water and energy are needed. It is noted that the solar panel may not contribute with a lot of
energy in comparison to the energy stored in the EV battery, suggesting that the PV system may be unnecessary for the specific application. However, some locations have more available sun, and additional PV panels could be included in the system to enhance the electricity generated. In future research on the V2W system, available data on electricity generation from a PV solar panel over time could be included, such as from a household PV system, to show the variability in available power from the RES over the day, at a certain location. The proposed system utilizes system parts that are today commercially available, and the system is scalable. The proposed V2W system would need to be charged from a grid-connected charging infrastructure not too far away from the location where the freshwater is needed. The power available should preferably be generated from RES, to ensure that the system is as friendly for the environment as possible. Thus, expanding the charging infrastructure and sustainable electricity generation for cities could be valuable for more than transportation. To ensure that future innovations including EVs can take place, the charging infrastructure could be planned and installed in the cities in advance, to not cause a bottleneck for coming new solutions and technical innovations. The analysis of the proposed system in this paper is limited as no experiments, prototypes, full analysis of system losses, or in-depth simulations have been designed or conducted yet. These aspects are important issues for future research. Nonetheless, the authors find the system promising and see potential for future research in the field of water production supported by electromobility, e.g., for disaster relief. The work on the water–energy nexus in general, and specifically on V2W, is highly interdisciplinary and requires knowledge in different fields, suggesting a collaborative approach now and in future research and development. Hopefully, this work could inspire other researchers and developers to contribute with innovative systems related to the increased electrification of the transportation sector.

6. Conclusions

There is a current transition towards more electrified and sustainable systems in society and additional EVs are expected on the roads in coming years. This is expected to result in more charging infrastructure in and around cities. In the future, many EVs could be self-driving, which could be beneficial when driving in areas where there has been a natural disaster or other severe crisis. The EVs of the future would not just be charged but could also be discharged, supporting another system in need of electricity. In the event of a crisis disrupting the water supply, flexible desalination systems could support communities with access to clean water. RO is one of the more common types of desalination technologies, often designed for stationary plants in coastal regions with a freshwater demand. As societal and natural crises are to be expected in the future, mobile systems for disaster relief can be interesting to design utilizing the new technology of more digitalized and electrified systems. The development would be interdisciplinary and require knowledge in for example both desalination technology and electromobility. In the following, a van-type EV with a portable PV panel and a small RO desalination system is proposed. The energy needed to power the RO desalination system, e.g., around 3 kWh/m³ freshwater, would be powered by the battery system of the vehicle and/or the solar PV system daytime, or, if available, the vehicle and the RO system could be powered by the local grid. There are some expected benefits of the proposed system; it is a mobile system without the use of fossil fuels, which could provide drinking water, transportation, and electricity, for rapid use in regions where it is most needed, such as during a natural or societal crisis. If additional tanks for water storage are used, e.g., on a trailer or inside the van, the clean water can be transported from the coastal region to another location where water is needed the most. Thus, a new mobile system has been proposed to be used for freshwater production and electricity generation for disaster relief. Along with the proposed system, the V2W concept has been introduced. Our findings support the idea of a holistic approach to the water–energy nexus.
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