



Records Department

December 11, 2019

Enrollment Verification

Re: Tim M. Klenner
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Germany
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To Whom It May Concern:

This is to verify that Tim M. Klenner is registered as a full time student at York College of Pennsylvania for the fall 2019 semester which began August 26, 2019 and will end December 17, 2019.

A student must be enrolled for and maintain a minimum of 12 credits per semester to be considered full-time.

York College of Pennsylvania is accredited by the Commission on Higher Education, Middle States Association of Colleges and Secondary Schools.

If I am able to be of further assistance, do not hesitate to contact me.

Sincerely,

Kristi M. Viands
Director of Records



Marshallplan-Jubiläumsstiftung
Austrian Marshall Plan Foundation
Fostering Transatlantic Excellence

Field Report

by **Tim Klenner**

Research stay from 26. August to 17. December 2019

York, PA, United States of America

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General impression of the research stay abroad:

The academic system at a college was completely different to the one at my school of applied sciences at first, but I got used to it really quick. Sometimes they request more autonomy by a student, like choosing your own courses and registering yourself, but then, professors gave a lot of graded homework.

The level of difficulty was mixed. One of my courses sounded cool (Critical Thinking and Problem Solving) and then turned out to be a math course, having the same objectives as German math until 12th grade. Then I had a few courses on the same standard that I used to have at my hometown school of applied sciences. One course was hard; I only had to learn how to code/program, but everyone else in there already had programming courses over their past semesters, while I had no knowledge at all.

Studying abroad was a big step towards independence for me. By having to leave my comfort zone to establish contacts and make friends all the time, I got used to it so much that now it is part of my comfort zone.

Although York is on the same height as Rome on the globe, the climate is colder than in Bavaria and parts of Tirol. Luckily, I decided to bring my winter jacket as a last moment decision.

Quality of the host institution:

York College of Pennsylvania was what I hoped for: A smaller college with less than 5000 students. The had a focus on engineering and nursing (nursing is a pre-step to medicine), and being a student of industrial engineering, having a huge engineering faculty was a good condition to start with.

Writing my MPS thesis, I met an electric engineering professor, who showed me a lot of projects, the students have been working on and one that was due the end of my semester. They built an electric car and several robots, just by themselves. Different courses worked on one project, each focusing on their major (so mechanical engineers did the mechanics, computer scientists did the programming, electrical engineers the electronics, etc.)

Contacts within the host institution:

I met several professors and even the vice-president of the college and a ton of students. My supervisor will stay in contact with me, and I hope I can stay in contact with the two professors that taught German. I also built a connection to the employees that helped me organize my documents.

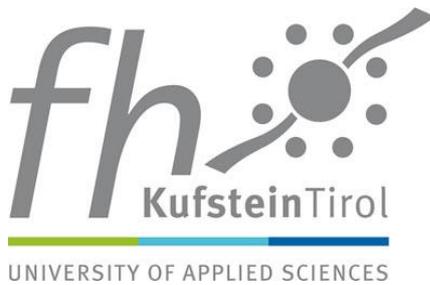
Recommendations for future Marshall Plan students and fellows:

- This semester will be expensive. I paid nearly \$5000, just for a shabby apartment for 3 months to live on campus. Books will not be covered by your tuition, and they are not cheap (\$100 per book on average).
- This is an excellent opportunity to make friends for life in different countries or simply establish contacts. Do not be shy, people from your host university will be curious about a lot, so it will not be hard to get into a conversation and keep it running.
- Try to learn about culture! Especially in the USA, you will see how several different cultures merge together and it is fun to have them explained and shown to you. In my case, I really did enjoy food and music from different cultures.
- When you choose your courses, pick carefully. Normally, they are given numbers that let you see the difficulty (a 101-course is an easy 1st year course, a 350 is a hard 3rd year course)
- It is not easy to get a Visa, start off the process early! Due to bureaucracy, it can take several months to have your Visa ready to take off to America.

And last but not least: Just enjoy your semester abroad as much as possible, have a great time!



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Status quo and perspectives of the electromobility in Germany and the USA

Abstract of the research study

Austrian Marshall Plan Foundation

Tim Klenner

Home: University of Applied Sciences Kufstein Tirol
Supervisor: Prof. (FH) Dr. Claudia Van der Vorst

Host: York College of Pennsylvania
Supervisor: Prof. Donald J. Hake II

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1. Introduction

One of the most controversial decisions that humanity has to face in the near future is whether they will stick to their traditional mobility that is almost exclusively powered by gas, or switch to an alternative. By just looking at the facts on the surface, alternatives seem to be the only reasonable path to pick, but by digging further into the topic, both sides have their advantages and disadvantages.

1.1. Problem

This decade has been defining for several industrial and technological evolutions. In most of those cases, you can see an exponential progress and growth of the market. Therefore, the population has to adapt to and accept the technology in order to make it become successful. Electric cars have been in the market for over a decade now and although they promise to be cleaner than gasoline powered cars, they still only have a small percentage of market share and can barely be seen on the streets.

1.2. Objectives

The goal of this study is to find out how fast adoption and acceptance of electric vehicles spread and how those affect the future. Projections are going to be made, how the industry of car-manufacturing will change, dependent on different values. The USA and Germany will be compared to each other. After stating general facts about electric vehicles to clear up any superficial knowledge and misunderstandings, this thesis will take a look at the reputation of electric cars and point out differences and similarities between Germans and Americans regarding their adoption and acceptance of this technology. Moreover, the study will differentiate between different perceptions of the development by American- and German car manufacturers.

1.3. Structure

By looking at the manufacturers and numbers of sales from the two countries, it should be possible to paint a general picture of the certain opinions of electric cars. Creating a survey for both Germans and Americans will help to see if those opinions comply with the truth. The survey will also simplify the differentiation between the US and Germany, by creating one form for each country and splitting participants up into different groups according to their country of residence.

Derived hypothesis:

What are the status quo and perspectives of electro mobility in the United States of America and Germany and what are the differences and similarities between their states of acceptance and adoption?

2. Basic explanation of the electric drivetrain

Electric vehicles have a drivetrain that features three major components: The battery is used to generate energy which is then transformed from direct current (DC) to alternating current (AC) by the inverter and then converted into power and circular movement by the electric motor, which transfers that circulation to the wheels.

The battery is essential to power an electric vehicle, because it is used to generate electrical energy from chemical energy. Basically, every power provider in any new electronic device nowadays is a lithium ion battery, because they have the least disadvantages. They offer a higher energy density, resulting in more power, lower weight and smaller size, than the nickel batteries we used to use. Different materials for the electrodes and the electrolyte solution cause different battery attributes. Using different materials results in dissimilar chemical reactions, which affect how the battery works, how much energy it is capable of storing and it causes different voltages.

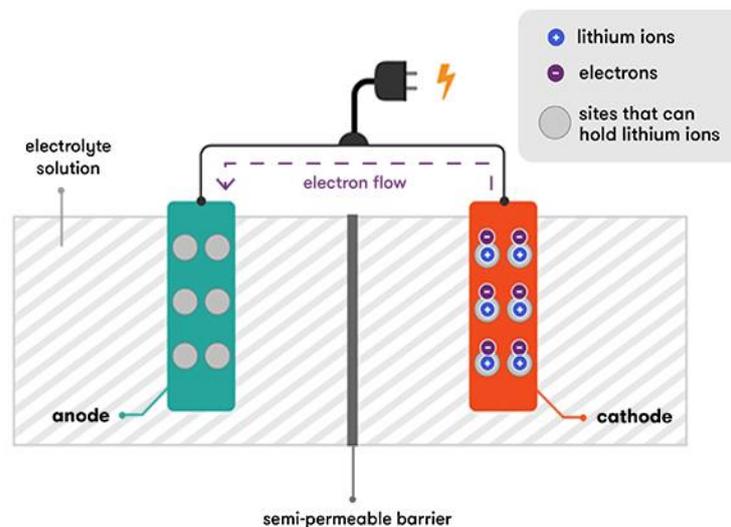


Figure 1: chemical process of a lithium ion battery

This reaction could theoretically run until nearly all of the lithium molecules are gone. In reverse, by charging the electronic device, the oxidation takes place at the metal oxide, creating a reduction on the right side until most lithium ions bind back at their starting position. No battery can ever be fully charged or discharged, because the “empty” electrode would implode.

The battery creates direct current that cannot be used to create continuously spinning circular power. Instead, altering current is needed, which is the reason why an inverter is included into every new electronic device powered by a standard lithium ion battery.

An induction motor consists of two major parts: the stator and the rotor. This study is looking at the alternating current motor, which has its stator on the outside and it is used to create a rotating magnetic field. You can basically describe it as a ring of electromagnets. Inside the stator is the rotor. When alternating current flows through the stator, it creates the magnetic field that is rotating around the stator. This magnetic field is used to force the rotor to rotate, creating the energy.

A battery cannot be fully charged or discharged, because the electrodes would collapse. The Battery Management System is responsible for that not to happen. The charging- and discharging current have to be surveilled, too. They have to decrease when the battery comes close to the points when the BMS shuts the charging or discharging completely down.

Another feature is Regenerative Braking. The software brakes as soon as you stop accelerating. Cars have a lot of kinetic energy and by using the brakes in normal cars, you waste it by creating heat. These regenerative brakes provide the possibility to convert it back into electrical energy. So basically, every time the car does not accelerate, it charges.¹

3. Alternative-fuel competitors

Lithium might become one of the most powerful and expensive resources soon, so researchers should keep looking for other options than battery electric cars. Electric vehicles include different types of power creation than batteries and two variants have prototypes or production cars on the market.

The hydrogen fuel cell is being used in several production cars already. The debate about this form of energy production is similar to the one about electric motors. Although it is environmentally more friendly than the internal combustion engine, hydrogen by itself cannot be found in the nature, so it has to be produced in a chemical process that splits up water in hydrogen and oxygen, or as a by-product in the exploitation of natural gas or oil. Those outcomes may seem harmless, but in order to gain the energy from merging the two parts again, the energy has to be invested into the endothermic chemical reaction to split them up.²

Another factor that is used against hydrogen fuel cells is the emission of NO_x, a dangerous by-product. Also, hydrogen can only be filled into the car's tank as either a -200-degree Celsius fluid or as gas. Because of the fluid's temperature, producers are building the vehicles to be refilled with gas, although this has a big disadvantage itself: the whole infrastructure has to be built, because refueling is specialized on fluids so far.

¹ cf. Toll, 2018.

² cf. D'Allegro, 2019

The fuel cell works similar to the hydrogen powered cell, but instead of refueling gas, which would require a new infrastructure, the cell benefits from running on a fluid, so new refill stations could theoretically be built over night with available knowledge and technology. Basically, this electrical motor is fueled by pure alcohol, which is split in CO₂ and hydrogen by heating it up to 300 to 400 degrees Celsius. The hydrogen is then used to power the fuel cell in the same way as the conventional hydrogen fuel cell does.³ But the process of splitting hydrogen from alcohol creates carbon dioxide as a by-product.

4. Determine differences

The result of this research study was surprising in many aspects. Tesla has a huge impact on people's mindsets, because they are the ones leading this innovation. Most participants seem to have accepted electric vehicles already, but the debate between battery electric vehicles and hydrogen fuel cell powered cars is clearly depicted in the survey and this study. In Germany, you see a bigger demand for hydrogen fuel cells, maybe because energy is generated through coal a lot, which keeps battery electric cars from being much cleaner than gasoline powered ones. It might have affected the adoption of electric cars in Europe and Germany, that Nissan and other manufacturers launched a few cars, that had bad range, bad reliability and durability, looked bad, or summed up: generated a really bad reputation on electric vehicles.

Tesla being located in your country results in a more developed recharging infrastructure, because they built and are still building Superchargers all over the world, but mainly in the US. Comparing the populous areas for Superchargers in Europe, like the Netherlands, to those in America, especially the Northeast and California, it is obvious that the US still has a lead in the development of infrastructure. The following graphs show the number of Superchargers in North America (blue), Europe (black), and the Asia Pacific area (green). Especially since the second third of 2017, the blue line continues to build its lead to Europe and Asia every year. As of January 1st, 2020, there are 861 of Tesla's charging stations in the Northern part of America, 505 can be found in Europe, and 396 have been built in Asia.

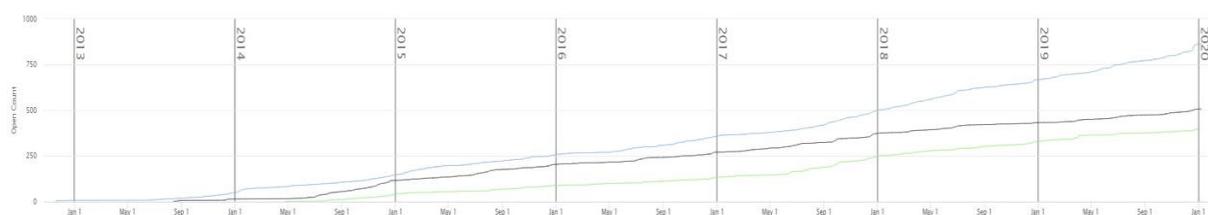


Figure 2: Open Superchargers by region⁴

³ cf. Wagner, 2018

⁴ Supercharger.info (2019)

One of the most exciting results is the strong acceptance of electric cars by actual owners. In Germany, only three people switched back to a gasoline car, while in America, no one did. It seems like experiencing is a good way to convince people about the advantages of electric cars. Also, there does not seem to be an owner, who regrets buying an electric vehicle.

America still struggles a lot with the acceptance, considering they have a better infrastructure to recharge batteries and the average price to recharge is lower, both publicly and at home. They have a lot of city traffic and the leading manufacturer is selling their cars cheaper in the country than anywhere else, because of customs and taxes. But the US is a huge country, therefore people are used to having long distance rides, for which the batteries are just not ready yet. But German participants have less faith in the industry of electric cars, probably because electric cars' state of art is further developed in the US than in Germany.

Germany has always been a car nation, with three of the four biggest companies being car companies (Volkswagen AG, Daimler AG, BMW). But it is not only about the internal combustion engine anymore, as it used to be for over 100 years and the big companies could face a dangerous threat. Sales are already decreasing for competition of the Tesla Model 3, and they need to react.

Volkswagen is turning their whole brand into a manufacturer of electric vehicles in the next decades, which is by far the most radical reaction to Tesla's innovation. They are helping to build up an infrastructure of charging stations over Germany and announced several electric cars for the future in the year 2019.

Other manufacturers do not react like that. Audi launched the e-Tron SUV this year, and they predicted that one third of all new Audi models in going to be electric by 2025 (including hybrids). Mercedes is going to launch the EQC in 2020 and they have not announced anything else in the direction of electric engines. What they have done is building a prototype car, called the Mercedes ESF, featuring a variety of innovations, like a screen in the rear window or a drone that sets up the warning triangle in case of an accident. This opens up more paths to go, with building knowledge about electric cars while continuing with their usual production. BMW just announced that they are going to expand their factory in Dingolfing, Germany for the production of electric cars. They want to launch the i4 and the iX3 in 2021, both with a 600-kilometer range. These three giants of German car manufacturing are taking steps towards the production of electric vehicles, but they continue to keep the option to pass on the development at any point by continuously releasing more gasoline powered vehicles.

5. Prediction of the future

This is the typical development of a disruptive innovation, led by Tesla. They started by selling high-priced cars to a niche market and made their way to an affordable, but qualitative Model 3. The answer to the first part of the derived hypothesis will be decided by the success of electric cars, which is based on their future developments. If successful, this kind of innovation can go two ways for existing companies: Either they disrupt themselves, by killing their main product line to make space for the new product or they stick to their origins and go bankrupt, by losing profit due to customers choosing the innovative product over theirs. So, in both ways, it will be a high-stake evolution for companies. But if the innovation does not turn out to be a successor, killing the main product line does also damage the company whereas sticking to the original product would probably gain them more market share, because competitors might jump the train, just to lose shares.

In the future, we will definitely see a change in acceptance and adoption of alternative-fueled cars. The main question is, which kinds of power supply and engine will be successful. With only three different systems available right now, there is not much of a choice, especially since all of them are electric and both fuel cells are powered by hydrogen.

But there is still a long way to go, until battery electric cars can be fully accepted by the population. The Porsche forum was not completely wrong, because emissions have to get lower, because this is the attitude that might give electric vehicles the decisive advantage over gasoline powered vehicles. The broad majority has to be taught about the current state of electric cars and other electric vehicles, because a lot of superficial knowledge can be found that may have been true five years ago, but has changed since then, due to the fast development of batteries. And Tesla shows how to do it with their fully solar powered Gigafactories. But that requires a lot of investment and although a lot of manufacturers already participate in the development and some announced their future being electric engines only, the minds of people have to change, so the industry can change, too.

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<https://www.explainthatstuff.com/how-inverters-work.html>

**Bachelor Degree Program
Industrial Engineering & Management FT
Wirtschaftsingenieurwesen**

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Kufstein, 30 January 2020

Bestätigung zur Vorlage bei der "Austrian Marshall Plan Foundation"

Sehr geehrte Damen und Herren,

hiermit bestätigen wir, dass Herr Tim Klenner, geb. 11.08.1999 im Bachelor Studiengang „Wirtschaftsingenieurwesen“ an der Fachhochschule Kufstein Tirol inskribiert ist.

Der Bachelor Studiengang „Wirtschaftsingenieurwesen“ ist ein 6-semestriges Fachhochschul-Studium mit praxisorientierter Ausrichtung, das zum Erwerb des akademischen Titels „Bachelor of Science (BSC)“ führt. Integrativer Bestandteil dieses Studienganges ist ein verpflichtendes Auslandssemester welches im 5. Semester des Studiums absolviert werden muss.

Herr Klenner hat ein Auslandssemester zum WS 2019/20 am York College, USA absolviert.

Für die „Austrian Marshall Plan Foundation“ bestätigen wir, dass Herr Klenner uns ein „Research Paper“ mit dem Titel „Status quo and perspectives of the electromobility in Germany and the USA“ eingereicht hat. Das „Research Paper“ wurde vom Studiengang im vollem Umfang anerkannt und positiv bewertet.

Mit freundlichen Grüßen,



Prof. (FH) Dr. Claudia van der Vorst
Director of Studies
Stvtr. Studiengangsleiterin Wirtschaftsingenieurwesen

