D9.5: Proposal for pricing and revenue models in the 7 uses cases

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D9.5: Proposal for pricing and revenue models in the 7 uses cases

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Technical References

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Project Coordinator	CIRCE Miguel Zarzuela - mzarzuela@fcirce.es
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[1] PU = Public

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Document history			
V	**Date**	**Partner(s)**	**Action**
V0.1	01/01/24	QiA	Table of Content available
V0.2	15/02/24	QiA	First Draft. Contribution from all partners
V0.3	30/06/24	QiA	First Consolidated version
V0.4	30/07/24	QiA	Final Consolidated version
V0.5	03/08/24	CIRCE	First Technical Review
V0.6	09/08/24	QiA	Final Consolidated version
V4.0	23/08/24	CIRCE	Final Quality Review

DISCLAIMER OF WARRANTIES

This project has used a standard methodology already developed in INTERPRETER project (Grant Agreement number: 864360), following EU recommendations. Ad hoc modifications were added to comply with the Grant Agreement conditions for INCIT-EV (Grant Agreement number: 875683).'

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0 EXECUTIVE SUMMARY

INCIT-EV aims to demonstrate innovative charging infrastructures, technologies, and associated business models to enhance the electric vehicle (EV) user experience, thus promoting greater market adoption in the EU. The project explores the subjective expectations of EV users through five demo environments situated in urban, peri-urban, and extra-urban conditions. These environments will deploy seven specific use cases across various locations: smart and bi-directional charging in Utrecht, dynamic wireless charging lanes in Paris, dynamic wireless charging for long distances in Versailles, a Charging Hub in a Park&Ride facility in Torino, superfast charging systems for EU corridors in Tallin, low power DC bidirectional charging for EVs, including two-wheelers, in Zaragoza, and opportunity wireless charging in Zaragoza.

The project's Work Package 9 focuses on the "Wide replication of use cases and solutions," leveraging the knowledge provided by partners and the experience acquired from the use case demonstrations to formulate comprehensive business models and exploitation strategies. The primary objective is to contribute to the improvement of the EV user experience through innovative charging infrastructures and ensure the replication of these novel solutions. Task 9.3 includes an elaborate analysis of revenue models and the pricing of the charging services in each use case. This report presents the results of the pricing and revenue analysis for the seven use cases, with the objective of informing decisions by key stakeholders in the electromobility domain, particularly public and private organizations investing in and deploying EV charging infrastructures.

To achieve this objective, three types of models were assessed: financial models, revenue models, and pricing models. Financial models capture the key metrics of money inflows and outflows over time. A sensitivity analysis is implemented in each financial model, resulting in proposed revenue and pricing models. Revenue models focus on different strategies to generate income from EV charging stations, corresponding to varying stakeholder approaches. Pricing models propose alternative ways of setting the price for the service. While increasing prices might seem necessary due to the high investments required, it is not always a viable solution since users are very sensitive to price increases, especially when there are cheaper charging options available.

The financial models provide general mathematical expressions that can be applied to determine financial performance using data from the demonstrators, project partners' experiences, previous deliverables, and specific assumptions. In terms of revenue models and pricing models, the report focuses on identifying alternatives and providing qualitative descriptions. Each use case has a dedicated chapter detailing the specifics of the model applied.

Several general assumptions underpin the analyses. The models and analyses typically focus on a single unit of EV charging solution, although in some use cases, such as UC6 in Zaragoza and UC4 in Turin, multiple chargers are considered as a block. The philosophy of this study is to use real data and account for what was proven in the pilots, although real-life combinations of chargers in an installation could differ to enhance profitability. Economies of scale are analytically considered when projecting financial performance five or ten years into the future. Lifecycle cost analyses (LCCA) performed in previous deliverables applied an improvement factor accounting for various cost reduction strategies, including scale and accumulated experience or learning effects. Financial models project revenues and costs as if the installation were made at the projected time, considering a lifetime of 15 years for all assets and a refurbishment after seven years costing around 30%. These figures can be modified in the attached Excel sheets, allowing recalculations to facilitate comparisons among use cases.

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Revenue models focus primarily on direct revenue from charging fees. Time-based models generate revenue proportional to the time the EV is parked at the charging point, suitable for low-power chargers in urban areas where drivers are accustomed to paying for parking. Energy-based models generate revenue proportional to the energy provided to the EV, suitable for high-power chargers in service areas on highways or places with low parking time. Alternative models include subscription-based models with fixed or variable fees or mixed models combining direct and indirect revenue streams, such as charging fees and advertising income. By analyzing customer preferences, market conditions, and financial projections, businesses can tailor their revenue models to maximize profitability and growth potential. Charging hubs can offer additional services, enhancing the user experience and potentially attracting more customers. Some commercial centers even offer free charging to attract clients.

Pricing strategies include cost-based pricing, value-based pricing, competitive pricing, and dynamic pricing. Cost-based pricing involves setting prices by adding a margin to the cost, ensuring at least break-even and possibly a profit margin. Value-based pricing sets prices based on the perceived value to customers, considering factors like charging speed, convenience, and location. Competitive pricing adjusts prices based on competitor offerings, while dynamic pricing varies based on demand, energy prices, time of day, and location.

Financial models are crucial for projecting future revenues, expenses, and cash flows to assess the financial viability of new charging solutions. The three-statement model integrates the revenue statement, balance sheet, and cash flow statement into one dynamically linked model. The discounted cash flow (DCF) model calculates the present value of expected future cash flows to determine the project's value. Key components of the financial models include revenue projections, cost structures, and investment requirements.

Horizontal technologies applied in INCIT-EV, such as Smart Charging, Vehicle-to-Grid (V2G), and Dynamic Grid Balancing, offer distinct economic benefits and challenges for EV users and grid operators. Smart charging optimizes energy use by adjusting charging times to avoid peak demand, reducing electricity costs and enhancing grid stability but requiring significant initial investment in smart hardware and software. V2G systems allow EVs to discharge power back to the grid, supporting energy storage and offering potential financial incentives, but they involve higher costs and potential battery degradation. Dynamic grid balancing optimizes energy use, avoiding peak rates, reducing overall energy costs, and improving the efficiency and reliability of the home's electrical system.

For EV users, smart charging provides cost savings by charging during off-peak hours despite the initial investment in advanced equipment. V2G systems offer income opportunities through grid support services but involve higher upfront and maintenance costs and potential battery wear. Dynamic grid balancing helps avoid peak electricity rates and reduces the risk of electrical overloads, making it a worthwhile long-term investment despite significant initial costs. For grid operators like GOPACS, smart charging reduces peak demand and operational costs, though it requires significant investment in advanced metering and control infrastructure. V2G systems balance supply and demand, improving grid reliability and creating new revenue streams, but entail high installation costs and potential battery degradation. Dynamic grid balancing optimizes energy distribution and avoids expensive infrastructure upgrades, though it involves upfront costs for implementation.

The revenue models are similar across these systems, with smart charging and dynamic grid balancing capping power peaks to reduce electricity tariffs and shifting consumption to lower tariff periods. V2G systems require higher investment but provide additional income through grid support services. Companies providing these services can adapt tariffs to maintain equivalent profit margins. For companies developing

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software algorithms, like Greenflux and Last Mile solutions, their clients will be grid operators such as GOPACS or other DSOs/TSOs. These operators benefit from reduced total power requirements and grid adaptation costs. The software as a service must offset CAPEX and OPEX, with the savings from reduced investment requirements compensating the service cost.

The use case analyses reveal specific insights into each model. For UC1a (Smart Charging), citizens will save significantly on electricity costs, and DSOs will see increased EBITDA from reduced operational expenses. UC1b (V2G Systems) involves costs for V2G adaptation and potential battery degradation, with income from grid support services. UC1c (Dynamic Grid Balancing in Private Garages) offers cost reductions similar to UC1a but on a smaller scale. Use Case 2 (Dynamic Wireless Charging Lane in Urban Areas) shows challenges in profitability due to high initial investment and lower IRR compared to WACC. Use Case 3 (Dynamic Wireless Charging for Long Distance) faces difficulties in achieving profitability due to infrastructure costs. Use Case 4 (Charging Hub in a Park&Ride Facility) has potential for profitability if optimized, benefiting from trends towards reducing urban pollution and city pedestrianization. Use Case 5 (Superfast Charging Systems for European Corridors) faces low occupancy and high investment costs. Use Case 6 (Low Power DC Bidirectional Charging for EVs and Two-Wheelers) demonstrates potential profitability with guaranteed occupancy. Use Case 7 (Static Inductive Charging) can be profitable with assured occupancy and sufficient equipped taxis.

In conclusion, the INCIT-EV project highlights the potential and challenges of various charging infrastructure models. Each use case demonstrates unique benefits and economic implications for both EV users and grid operators, with profitability largely dependent on occupancy rates, initial investment, and operational efficiency. The adoption of these technologies requires careful consideration of cost structures, revenue models, and market conditions to ensure long-term viability and success. Hereinafter, the main economic results from UC2 to UC7.

BUSINESS MODELS	UC2 500 m	Paris Cent. DWPT	UC3 25 km	Paris Pher. DWPT	UC 4	Turin	Hub 150 kW
INCITEV	UC2. 1-E-Trench 30 kW, 500 m		UC3. 1 E-Corr.r 90 kW power t., 25 km		UC4. 1 Charger 150 kW and 2 chargers 3.6 kW		
	2030	2035	2030	2035	2025	2030	2035
PROFIT AND LOSSES							
1. TOTAL REVENUES	135,518 €	134,626 €	2,317,848 €	2,316,689 €	167,521 €	159,311 €	151,503 €
2. TOTAL EXPENSES	-78,688 €	-73,751 €	-691,933 €	-662,044 €	-44,225 €	-41,121 €	-38,259 €
3. IBITDA	56,830 €	60,875 €	1,625,914 €	1,654,645 €	123,296 €	118,190 €	113,244 €
4. NET INCOMES	548 €	7,476 €	548,695 €	628,788 €	77,166 €	74,864 €	72,572 €
KPIS							
1. NET PRESENT VALUE	-449,566 €	-330,208 €	-1,678,245 €	-488,159 €	554,375 €	546,407 €	537,588 €
2. INTERNAL RATE OF RETURN	-1.42%	0.34%	4.89%	5.96%	27.61%	23.18%	24.46%
3. WACC	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%
4. LIFETIME	15	15	15	15	15	15	15

BUSINESS MODELS	UC5	Tallinn	SF 200 kW	UC6	Zaragoza	25 kW	UC7 Zaragoza	OWPT 50 kW
INCITEV	UC5. 1 Charger 200 kW			UC6. 1 Charger 25 kW for EV and two wheels			UC7. 1 Charger 50 kW 0WPT	
Years described in the Deliverable in detail	2025	2030	2035	2025	2030	2035	2030	2035
PROFIT AND LOSSES								
1. TOTAL REVENUES	80,895 €	84,671 €	70,496 €	37,447 €	35,612 €	33,867 €	32,672 €	32,624 €
2. TOTAL EXPENSES	-32,535 €	-29,797 €	-25,993 €	-20,941 €	-21,219 €	-19,096 €	-17,860 €	-16,329 €
3. IBITDA	48,360 €	54,875 €	44,503 €	16,506 €	14,393 €	14,771 €	14,812 €	16,295 €
4. NET INCOMES	21,430 €	31,918 €	25,464 €	7,220 €	5,979 €	7,143 €	6,337 €	8,314 €
KPIS								
1. NET PRESENT VALUE	55,427 €	131,927 €	76,935 €	-32,595 €	1,250 €	-11,259 €	43,276	73,915
2. INTERNAL RATE OF RETURN	9.32%	17.74%	14.80%	5.99%	6.65%	9.03%	12.25%	17.74%
3. WACC	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%
4. LIFETIME	15	15	15	15	15	15	15	15

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ACRONYM LIST

Acronym	Definition
AC	Alternative Current
CAPEX	Capital Expenses
CPO	Charge Point Operator
CPs	Charging Points
COGS	Cost of goods sold
DC	Direct Current
DSO	Distribution System Operator
DWPT	Dynamic Wireless Power Transfer
EBITDA	Earnings before interest, taxes, depreciation and amortization
EBIT	Earnings before interest and taxes
ERP	Equity Risk Premium
GOPACS	Grid Operator Platform for Congestion Solution
IP	Innovation Premium
IRR	Internal Rate of Return
LCCA	Life Cycle Cost analysis
MRA-E	Metropolitan Region Amsterdam Electric
MW	Megawatts
NPV	Net Present Value
OCPP	Open Charge Point Protocol
OPEX	Operational Expenses
O&M	Operation and Maintenance
OWPT	Opportunity Wireless Power Transfer
P&L	Profit & Losses Account
PV	Present Value
PWM	Pulse Width Modulation
Rd	Cost of Debt

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Acronym	Definition
Re	Cost of Equity
REs	Renewable Energies
Rf	Risk free Rate
SG&A	Selling General and Administration
Td	Marginal tax rate
TSO	Transmission System Operator
UC	Use Case
V2G	Vehicle to Grid
VAT	Value Added tax
VPP	Virtual Power Plant
WACC	Weighted Average Cost of Capital
WPT	Wireless Power Transfer

0.1 LIST OF TABLES

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0.2 LIST OF FIGURES

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1 INTRODUCTION

INCIT-EV aims to demonstrate an innovative set of charging infrastructures, technologies, and associated business models, ready to improve the EV users experience beyond early adopters, thus, fostering the EV market share in the EU. The project will seek the emergence of EV users' subjective expectations. 5 demo environments at urban, peri-urban, and extra-urban condition will be ready for the deployment of 7 use cases (UC) addressing:

- UC1: Smart and bi-directional charging optimized at different aggregation levels – Utrecht.
- UC2: Dynamic wireless charging lane in urban areas - Paris
- UC3: Dynamic wireless charging for long distances -Versailles
- UC4: Charging Hub in a Park&Ride facility – Torino
- UC5: Superfast charging systems for EU corridors - Tallin
- UC6: Low power DC bidirectional charging infrastructure for EVs, including two-wheelers - Zaragoza
- UC7: Opportunity wireless charging – Zaragoza

1.1 Background

Incit-EV dedicates its work package 9 to the *"Wide replication of use cases and solutions: business models and exploitation strategies"*. The background for the business models and exploitation strategies is the knowledge provided by the partners and the experience acquired from the use cases demonstration.

1.2 Objectives

To contribute to improve the EV users experience through innovative charging infrastructures, and ensure the replication of these novel chargers, task 9.3 *"Business approach from stakeholders' viewpoint"* includes the elaboration of a comprehensive analysis of the revenue models and the pricing of the charging services in each use case.

This report presents the result of the **pricing and revenue analysis** for the 7 Use Cases with the objective of informing the decisions of key stakeholders in the electromobility domain, with special attention to public and private organizations investing and deploying charging infrastructures for EVs. This deliverable D9.5 takes some of the cost information from deliverable D9.4 where a complete Life Cycle Cost Analysis (LCCA) was done for each Use Case (representing a type of e-charger). In all the cases, except UC1, a complete business model is provided for years 2025, 2030 and 2035 for the conductive technologies (wired, UC4, UC5 and UC6) and years 2030 and 2035 for the wireless technologies (UC2, UC3 and UC7). The year 2030, in the conductive technologies, was selected to implement the sensitivity analysis and year 2035 in the wireless cases. The reason is the degree of maturity and give 5 years to allow the technology reduce costs due to the learning curve and automatization of processes.

UC1 is an exception in the way the analysis is done because is "**a software as a service**" model instead of the evaluation of an "**asset**". The advantage of this software to provide Smart charging or V2X is difficult to put in figures as it reduces power needs (representing also REs deployment and grid adaptation) and more studies are required to evaluate its advantages, that are however, very clear.

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2 METHODOLOGY

To achieve the objective of this report, three types of models will be assessed:

- **Financial models**, capturing the key metrics of money inflows and outflows over time. A sensitivity analysis is implemented in each of them and as a consequence, a revenue and pricing models are proposed.
- **Revenue models.** There are different approached to get incomes from a EV charging station, corresponding to different strategies among the stakeholders involved.
- **Pricing models**, proposing alternative ways of fixing the price of the service. Although the increase in prices apparently is a need due to the difficulties to get the chargers be occupied enough time or to depreciate the sometimes large investments required, is not always a solution as users are very sensible to pricing increases when there are some other cheapest charging options.

In the case of the business models, this chapter two explains the general mathematical expressions that can be applied in subsequent sections to determine the financial performance. The formulas will use the data gathered from the demonstrators, project partners' experience, previous deliverables and assumptions made below.

In the case of the revenue models and the pricing models, the focus of this chapter is on the identification of alternatives and their qualitative description. Then, each use case will have a dedicated chapter with the specificities of the model applied.

2.1 General assumptions

- The models and analyses are performed in **one single unit of EV charging solution**. However, in two Use Cases, there are more than one charger (UC6 in Zaragoza and UC4 in Turin). In those cases, the study is done as a block. The philosophy of this study is to use real data and account what it was proven in the pilots, although in the real life, in some cases, the combination of chargers in the same installation, could be different to make them profitable.
- The **economies of scale** are considered analytically when we jump to the analysis 5 or 10 years later in the case of the conductive technologies (2025 to 2030 and 2035) and five years later in the wireless cases (2030 to 2035). The lifecycle cost analysis (LCCA) performed in D9.4 applied an improvement factor that accounted for several cost reduction strategies including scale and accumulated experience or learning effects. The financial model in 2030 for instance, projects the revenues and costs as if you made the installation at that time (in deed, the investment one year earlier, in 2029). In all cases, it has been considered a lifetime of 15 years for all assets and a refurbishment after 7 years costing around 30%. although this is not necessarily the case in the real time. These figures can be modified in the Excel sheets, and all might be recalculated automatically. However, it was considered fix in the study to allow a better comparison among UCs.

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- The financial models in the Excel sheets attached in annexes, consider the same years than those used in the LCCA, but only year **2030 in the conductive UCs and 2035 in the wireless UCs**, are used for the **sensitivity analysis**.
- The financial models include a tab for "**notes**" that essentially describes the UC and the main assumptions, a "**summary**" tab (with main results for the years mentioned) , a tab of "**assumptions**", that feed all the remaining tabs, and then a "**revenues tab**", an "**OPEX**" tab and the "**P&L**" tab. Then, there are some other supporting "tabs" with tariff projections and analysis and the table of EV and chargers' projections that comes from D9.2.
- In the "**assumptions"** tab, the "**occupancy rate**" of the charging points is a key factor. The occupancy rate affects the energy consumption and consequently, the incomes from the charging sessions. The "occupancy" depends on several factors like the location, the number of vehicles equipped to charge wireless for example", but also by the limitations of the charging point (there is a maximum number of charging events possible daily depending on the power). If the occupation overpasses the maximum technical vehicles that can charge daily considering also the efficiency of the location, the vehicles charging should be those admissible in the best technical case but if the occupation, provides less vehicles to those acceptable technically, those number of vehicles will cap the total energy consumed.
- In a given city, the number of EV per charging point (CP) evolves over time. There is **an optimum number of EVs per CP**. If there are less EVs per CP below the optimum, the Charging Stations will work at full capacity and will be profitable, but many users will be frustrated because they will not find a place to charge. By the contrary, an excess of chargers per EV, will generate satisfaction in users but those Charging Stations (CS) will not be profitable in many cases. Ideally, CS growth should go hand in hand with EV growth.
- In the study, only the direct commercialization of electricity to EV users by means of a flat (average tariff) is considered as a source of incomes. The CAPEX is amortised during the lifetime (15 years).
- There is not too much information on real salaries and wages for the future UCs especially in those pilots with low TRLs, with unprecedent solutions. In those cases, a projection was done in D9.4 considering the expected difficulties in the Operation and Maintenance Services.
- The **electricity prices and evolution of the tariffs** are based on real data gathered from Spanish electricity retailers in the different power categories and the reference charging prices from AEDIVE (Spanish Electric Vehicles Associations). The reference prices are projected for the whole study period. Some studies were done also for other countries, but the prices are flat for the different hours just to give an approach of the incomes.
- The **Corporate Tax Rate, and VAT** applied are specific to the pilot cities in which each solution is demonstrated.

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2.2 Revenue models

The revenue model outlines the strategy for generating income. It depends on various factors such as target market, competition, regulatory environment, and the company's strategic goals. Often, a combination of models is used to diversify revenue streams and mitigate risks.

For businesses based on exploiting EV charging assets, the revenue could be:

- **Direct Revenue**: Income from charging fees.
- **Indirect Revenue**: Income from other services related to or co-located with the asset, such as grid services, advertising, data analytics, or maintenance. In our study, indirect revenues were mentioned but not considered. The gap between incomes and cost is defined and should be covered with other options.

Focusing on **direct revenue streams** for charging fees, there could be different models, depending on the concept for which the end user pays:

Time-based models.

- The revenue is proportional to the time that the EV has been parked in the charging point. This model could be interesting for low-power chargers, placed in urban areas, where drivers are used to pay for parking.
- The value provided differs from one customer to another depending on the time, the state of charge, or the capacity of the EV to charge at the maximum power provided by the charger (e.g. 22 kW).

Energy-based models.

- The revenue is proportional to the energy provided to the EV. This model is especially interesting for high-power chargers, placed in service areas in highways or places with a low parking time.
- The value provided is similar from one customer to another, as parking time should be as short as possible and the power as high as possible. The higher the power of the charger, the better the experience but also the more expensive.

Alternative models

- An alternative model might be based on subscription to a charging network (with a fixed fee or a combination of fixed fee for the benefits plus a variable fee for the energy).
- Other models could use mix direct and indirect revenue streams, for example, having incomes from charging fees and advertising. The user could benefit from discounts if he or she accepts watching personalised commercial offers.
- By analysing customer preferences, market conditions, and financial projections, the business can tailor its revenue model to maximize profitability and growth potential
- Charging hubs can offer different services to users like coffee shops, shops, interconnection with other means of transport, etc.

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- Commercial Centers sometimes offer the charging services for free to attract clients.

2.3 Pricing strategies

The pricing strategy can be defined as the method used to set the prices for a product or service. It involves determining how much customers are willing to pay, assessing the competition, and understanding the cost structure to achieve the desired level of profitability and market positioning.

In the context of Incit-EV, adopting the right pricing could be key in maximizing adoption of the proposed charging solutions and the profitability, while meeting customer expectations.

The following pricing strategies could be applied in Incit-EV Use Cases:

Cost-Based Pricing

- The pricing is fixed applying a margin to the cost. Therefore, it is based on the calculation of the initial investment and ongoing operational costs through the lifecycle of the asset.
- The minimum price is the one that reaches break-even, i.e., the one that allows to compensate the operational expenses, depreciation, interests and taxes. From there, a profit margin could be fixed and shared among the estimated number of services (minutes for a time-based revenue model or kWh for an energy-based model).
- A cost-based pricing could also be applied case by case, i.e., starting from the corresponding share of fixed costs of the asset, the variable cost of the energy consumed by each customer would be added to the final ticket.

Value-Based Pricing

- The pricing is fixed assessing how much customers are willing to pay based on the value provided (e.g., charging speed, convenience, location, etc.),
- This strategy should perform a price sensitivity analysis, conducting surveys or focus groups to understand how sensitive customers are to price changes.

Competitive Pricing

- The pricing is fixed, after ensuring that the revenue would be enough to compensate the costs, based on the pricing of competitors.
- The comparison of the value proposition of the service provided by competitors and the one provided by Incit-EV solutions can be used to justify a price increase.

Dynamic Pricing

- The pricing is, in this case, variable. Prices are adjusted based on demand, energy price, time of the day, location, etc.
- This strategy could be especially convenient in charging points implementing V2X functions, as there is a complex exchange of energy and value that can be calculated dynamically and transferred to the user.

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2.4 Financial models

The Financial models are mathematical representations of the performance of a business, project, or investment. There are different types of financial models depending on their purpose.

In the context of this deliverable, a financial model has been elaborated for each Use Case or new charging solution proposed in Incit-EV with the objective of projecting the future revenues, expenses, and cash flows to understand the financial viability of the business.

- **Three-statement model**

  Typically used to report the financial state of a company, could be useful in this case. It integrates, into one dynamically linked model, the revenue statement, the balance sheet, and the cash flow statement.

- **Discounted Cash Flow (DCF) model**

  It is widely used to analyse investments and innovative projects. In this financial model, the value of the company or project is determined based on the present value of its expected future cash flows.

To focus on the most relevant parts of the model providing the right level of detail for an informed decision making, each use case will analyse the key components described below, which are extracted from the two aforementioned framework models.

2.4.1 Revenue Projections

The total revenues of the EV charging business, in annual terms, is provided by the following formula:

$$Total\ revenues = Sales\ of\ electricity\ without\ VAT + Grants$$

The economic amount of the sales directly obtained from providing electricity are dependent on two factors: the fare or tariff, and the volume or amount of energy provided:

$$Sales\ of\ electricity\ without\ VAT = Fare * Volume$$

The term *Fare* means the price that the end user of the charging point pays for the energy. It is provided in *€/MWh*. The calculation of the fare is based on a reference value, and it is contemplated the possibility to correct for inflation. The annual values are reduced a 1% yearly as the cost of the electricity will drop as soon as the REs will gain weight.

$$Fare = Ref\ selling\ price\ * (1 + prices\ inflation\ rate)^{current\ year - initial\ year}$$

The fares were taken from real cases, according to the power levels. In the "tariff projections" and "tariffs' analysis" tabs, some real cases were studied calculating an average figure according to the electricity costs by time period.

The *Volume* is the amount of energy annually transferred to the clients' EVs measured in *MWh*. This term is estimated as the number of foreseen charging events times the net power is transferred:

$$Volume = Foreseen\ charging\ events * Net\ power\ transferred * Nº\ of\ days/year$$

Where:

$$Foreseen\ charging\ events = \ Maximum\ charging\ events\ daily * Occupacy\ rate$$

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and

$$Net\ power\ transferred = Charging\ point\ rated\ power * transmission\ efficiency$$

The remaining term in the main formula is the *Grants* that the financial could have. Depending on the type of grant, the formula may need to be adapted. If, for example, the Government subsidises the energy provided through the charging point through a "green premium" factor, the formula would be:

$$Grant = (Market\ price\ of\ closest\ substitute + Green\ preium) * Volume$$

The Grant represents the required gap to reach at least the breakeven between incomes and expenditure.

2.4.2 OPEX Projections

The Operational Expenses (OPEX) were estimated in D9.4 based on the operation and maintenance costs (O&M). However, to perform a complete financial analysis, it is necessary to account for all the terms involved in the provision of the service, including those related to electricity supply and consumption, as well as the selling general and administrative costs (SG&A) and the depreciation of the equipment. With this in mind, the overall OPEX formula is:

$$OpEx = Operation\ and\ Maintenance\ costs + Electricity\ costs + SG\&A + Depreciation$$

The O&M can be split into at least two sub-components:

$$Operation\ and\ Maintenance\ costs = Operation\ cost + Maintenance\ cost$$

Calculated as:

$$Operation\ costs = Operation\ costs\ in\ year 1\ except\ Maintenance\ CAPEX * (1 + inflation\ of\ costs)^{current\ year - initial\ year}$$

and

$$Maintenance\ cost = Maintenance\ cost\ in\ year 1 * (1 + inflation\ of\ costs)^{current\ year - initial\ year}$$

As for the electricity costs, the two sub-components are:

$$Electricity\ costs = Fixed\ term + Variable\ term$$

Where the fixed term can be calculated based on the current market price, with a 1% annual reduction to consider several improvement factors (including competitiveness in the energy sector) and discounting the inflation.

$$Fixed\ term = Transmission\ \&\ Distribution\ power\ term = Reference\ tariff\ cost\ in\ current\ year * 99\% * (1 + inflation\ of\ costs)^{current\ year - initial\ year}$$

The variable term of electricity is basically calculated as the sum of the electricity cost, the compensation of surplus of production and other variable factors such as social subsidies or meter rental.

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$$\begin{aligned} Variable\ term = {} & (Electricity\ price\ per\ MWh\ * energy\ consumed\ in\ MWh) \\ & + (other\ T\&D\ compensation\ variable\ costs * energy\ consumed\ in\ MWh) \\ & + (Social\ subsidy + meter\ rental + other) \end{aligned}$$

The SG&A term is calculated as a percentage of the operation costs, usually around 7%.

Finally, the depreciation is calculated as the sum of the upfront costs of the Asset (CAPEX) , the equipment for billing and communication (first year of operation) and the Renewal costs (Maintenance CAPEX) in year 7 of the lifetime.

2.4.3 Profit and losses

The profit and loss (P&L) account or income statement summarizes the revenues, costs, and expenses incurred during a specific period, usually a year. This statement provides a snapshot of a company's financial performance and shows whether the business made a profit or incurred a loss during the period.

The term EBITDA means Earnings Before Interests, Taxes, Depreciation and Amortization, and is basically:

$$EBITDA = \text{Revenues} - \text{Expenses}$$

where depending on the revenue streams of each business case can vary. A general expression could be:

$$Revenues = Revenue\ from\ sale\ of\ electricity + public\ grants$$

while the expenses are the direct costs attributable to the production of the goods sold (COGS) by the business. This includes raw materials and labour costs.

$$Expenses = COGS + SG\&A + other$$

The EBITDA minus the depreciation and amortization cost is also known as EBIT, which corresponds to the income discounting the total depreciation of infrastructure and equipment.

Finally, the interests, that vary depending the cost of capital (WACC) for the business, based on its risk rating, and the taxes, that vary depending on the country laws. For example, in Spain, the general Company Tax Rate is 25% of the EBIT.

The ultimate indicator of interest in this model is the net Income or loss of the business, which is calculated as follows:

$$\text{Net Income} = \text{EBITDA} - \text{Depreciation} - \text{Amortization} - \text{Interests} - \text{Taxes} - \text{Other}$$

2.4.4 Sensitivity analysis

Sensitivity analysis is a straightforward yet somewhat restricted technique for assessing the uncertainty of the business model outcomes. In the study two ways have been implemented:

- **A multivariable analysis.** Several parameters can be changed at same time. At its core, it can entail adjusting a single variable at a time by a fixed percentage, such as +10% and then -10%, or by an specific amount, to observe the impact on the Net Present Value (NPV) and the Internal Return Rate (IRR). A minor change in NPV (for instance, a ±10% variation of a model variable leading to a ±3%

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shift in NPV) suggests that the uncertainty of the variable is minimal and not crucial for decision-making. On the other hand, a significant percentage change in NPV indicates that the conclusions of the financial modelling or its foundational assumptions may be questionable. In such cases, it might be beneficial to allocate additional resources to acquire a more accurate estimate of the variable, although this does not mitigate the risk associated with its fundamental volatility.

- **Dual variable analysis**. Only two variables are compared at same time, permitting a best approach to the impacts of by two single parameters in the whole business model. The CAPEX is taken as one of the fix parameters once other variables are compared to.

In the following sections, after the financial model is elaborated and computed for each Use Case, a sensitivity analysis is performed, modifying certain key variables that could have significant effects on the potential and profitability of the business case.

Each sensitivity analysis compares the NPV and IRR of a base case with the results that would be obtained in the alternative cases (7 options) that have the variation you would like to introduce. The most impacting variables have been included by default but It is possible to add some other variables but that would require rearrange all the model.

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3 USE CASE 1. USER-CENTRIC SMART CHARGING AND BI-DIRECTIONAL CHARGING

3.1 Description

3.1.1 UC1 Introduction

The UC1 aimed to demonstrate that by managing and optimizing a group of chargers as a single entity instead of each individual charger/grid connection, the number of charging stations that can be installed in an area multiplies by a factor. The aim of UC1 was to test a regional smart charging infrastructure for public charging in order to achieve the following goals:

- Avoid grid congestion
- Improve the business case of EV-charging
- Increase sourcing of (locally produced) sustainable electricity

Within UC1, there are three subcases, a, b and c, described below

3.1.2 UC1 description

3.1.2.1 UC1a Smart Charging in Haarlem

The UC1a Smart Charging project in Haarlem involves the City of Haarlem and TotalEnergies as the Charge Point Operator for public AC charging infrastructure, with MRA-Electric as the Owner. Approximately 100 charging stations (200 charge points) have been selected for the Aggregated Smart Charging group. Each station has a 3x25A grid connection, supplying from 7 to 22 kW AC per socket. When both connectors are in use, the available 22 kW is divided between the two sockets through smart load balancing, with some stations having an increased grid connection (3x35A). Greenflux developed a Smart Charging Algorithm for congestion management using the Open Charge Point Protocol (OCPP), functioning as a Virtual Power Plant (VPP). Users can request high priority charging, which is always granted, with control focused on power. A load forecast is created using historical data from the charge points for the following 24 hours. Input from the DSO (Congestion profile; required peak load reduction) is separately collected. The flexibility from the charging needs is calculated, and optimization is performed based on this flexibility and the required peak load reduction, resulting in an optimized aggregated load forecast. The GOPACS flexibility trading platform is utilized, reducing power by 10%-25% during peak hours (0.8 kW per charging station). The innovative aspect is the lack of contracts with EV drivers, who can opt-out via an application for priority charging. Key points to be addressed include the cost (CAPEX) of a 7 kW to 22 kW charging station and the additional costs for converting it to Smart Charging, the cost of the GOPACS Platform and how these extra costs are charged to users, the maintenance and operation costs (OPEX) for one charging station and the GOPAC Platform (for 100 charging stations), including personnel and other costs. Finally, the savings in grid adaptation and RES deployment due to the Smart Charging Ecosystem must be calculated.

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3.1.3 UC1b. Bidirectional Charging project in Utrecht

The UC1b Bidirectional Charging project in Utrecht focuses on interoperability by integrating two new EV models into the V2G-EV system, initially with two public bidirectional e-car charging stations, expected to grow to five stations and five e-cars. The project demonstrates the use of shared EVs for local communities through a civil initiative in Odijk. Communication between the infrastructure, EV, and user interface is based on open protocols, enabling the car-sharing platform by Goodmoovs using ISO 15118 and OCPP 2.0. This platform shares the state of charge of specific vehicles with users and provides real-time monitoring of bidirectional charging. OCPI 3.0 is used for the charging station back-office to optimize the charging direction according to energy market prices. The development of OCPP 2.0 is led by Wedrivesolar, which is the hub of a consortium including entrepreneurs, researchers, public bodies, and stakeholders. This consortium exploits bidirectional charging stations and shared EVs, with partners like ElaadNL for standardization, DSO Stedin for integrating bidirectional charging into the electricity grid, Utrecht Sustainability Institute for scientific validation, and the city and region of Utrecht for upscaling. The charging stations, developed by WDS, are 22 kW smart/V2G charging points compatible with ISO 15118 and standard Type 2 charging. The smart-charged electric shared cars include models like Renault ZOE, Tesla Model 3, and Hyundai Kona, with plans to add V2G Hyundai IONIQ5 cars to reach a total of five vehicles. The back-office is developed by Last Mile Solutions. Additionally, the project uses TOMP-API (a Dutch API for communication between transport operators and MAAS providers) to connect car-sharing data with aggregators, facilitating planning for when cars can be charged and testing load shift potential. A connection to the GOPACS network congestion trading platform between asset operators and TSO/DSO is also being developed.

3.1.4 UC1c Private charging in an apartment block in Purmerend

UC1c focuses on private charging in apartment blocks with owner associations in Purmerend. This use case involves the commissioning of intelligent charging infrastructure integrated into the grid connection of a privately owned apartment building. The project includes the installation of twelve 11 kW chargers, which will be managed by a single Charge Point Operator (CPO) for the entire building. The system will employ Dynamic Load Balancing to continuously monitor the available capacity in the building and distribute it among the charge points. The preferences and priorities for the system can include AC/DC high/low power, cost-efficiency in operation and investment, reliability, flexibility, safety, CO_2 emissions reduction, and optimizing the utilization of locally produced energy. The project is organized by MRA-E.

3.1.5 Summary

These use cases highlight different approaches to smart and bidirectional charging in various contexts, aiming to optimize energy use, manage grid load, and support the adoption of electric vehicles in both public and private settings. In all three cases, software provides the service and advantages of system management

Furthermore, smart charging features are expected to foster the utilisation of locally based RES (such as PV) for the charging system, maximising the RES production and reducing cost for the consumers. Additional benefits can be made through smart charging: trading on the Amsterdam Power Exchange or avoiding net congestion.

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3.1.6 Key business roles

In UC1,

The **GOPACS** (Grid Operators Platform for Congestion Solutions) is a collaborative initiative owned and managed by a consortium of Dutch grid operators. The consortium includes both transmission system operators (TSOs) and distribution system operators (DSOs). The primary members of GOPACS are:

- TenneT TSO B.V.: The national transmission system operator in the Netherlands.
- Enexis Netbeheer B.V.: A major distribution system operator.
- Stedin Netbeheer B.V.: Another significant distribution system operator.
- Liander N.V.: One of the largest distribution system operators in the Netherlands.
- Westland Infra B.V.: A distribution system operator focused on the Westland region.

These grid operators work together through GOPACS to address and manage congestion in the electricity grid by leveraging flexibility from various sources.

The **CPO (TotalEnergies**) has a central role in the ecosystem, performing the key activity from which it obtains revenues: procure, install, maintain, and operate the chargers under a public procurement contract (subcontracting the customer relations, connectivity, etc.)

The **MRA-Electric (MRA-E)** is a **public** initiative. It is part of the Metropolitan Region Amsterdam (MRA), which is a collaborative effort involving public entities such as municipalities, provinces, and other governmental organizations within the Amsterdam Metropolitan Area. The MRA-E focuses on promoting electric mobility and the development of the necessary charging infrastructure to support the transition to electric vehicles in the region. The MRA-E is the owner of the Charging Stations and the one who must allow data aggregation.

Finally, **Greenflux,** provides smart charging solutions and algorithms for load management. They have developed the Smart Charging Algorithm for congestion management.

In UC2, they key actors are:

Wedrivesolar which is the hub of a consortium including entrepreneurs, researchers, public bodies, and stakeholders. This consortium exploits bidirectional charging stations and shared EVs, with partners like ElaadNL for standardization. Key Activities of We Drive Solar:

- Bidirectional Charging: Developing and implementing bidirectional charging stations that allow electric vehicles to both charge from and discharge electricity to the grid.
- Shared EVs: Promoting the use of shared electric vehicles to reduce the number of cars on the road and lower emissions.
- Renewable Energy Integration: Integrating solar energy and other renewable sources with their EV charging infrastructure to create a more sustainable energy ecosystem.
- Collaborative Projects: Leading and participating in various consortia and collaborative projects to advance the development and adoption of smart charging technologies.

Stedin is the DSO for integrating bidirectional charging into the electricity grid,

Last Mile Solutions, equivalent to Greenflux in UC1a, is responsible for developing the back-office system for managing the bidirectional charging stations. Specifically.

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- **EV Charging Management**: They develop software and systems to manage the operation of EV charging stations, including bidirectional (Vehicle-to-Grid, V2G) systems.
- **Back-Office Solutions**: Provides backend systems that handle data processing, billing, user management, and integration with other platforms.
- **Integration with Charging Protocols**: Ensures compatibility with industry standards and protocols such as ISO 15118 and OCPP (Open Charge Point Protocol).
- **Support for Innovative Charging Technologies**: Supports the implementation of advanced charging technologies, including bidirectional charging and integration with renewable energy sources.

Finally, The **GOPACS** (Grid Operators Platform for Congestion Solutions) is also a key actor in this solution.

In UC3,

This is a simplified ecosystem managed by **MRA-E** focuses on private charging in apartment blocks with owner associations in Purmerend

3.2 Revenue model

In advance to explain the Revenue model, it is important to clarify the advantages and disadvantages of the Smart charging compared to the V2G bidirectional charging and the dynamic grid balancing.

Smart charging offers several benefits, including optimizing energy use by adjusting charging times to avoid peak demand, which can lower electricity costs and enhance grid stability. It allows for flexible load management, integrating renewable energy sources efficiently, and providing users with control over their charging preferences. However, it can involve higher upfront costs for smart hardware and software, and balancing user needs with grid requirements can be complex. Additionally, smart charging systems do not offer the ability to return power to the grid, limiting their support for grid stability compared to bidirectional systems.

Bidirectional Vehicle-to-Grid (V2G) charging provides significant advantages, such as enhancing grid stability by allowing vehicles to discharge power back to the grid, supporting energy storage, and integrating renewable energy sources effectively. It can also offer potential financial incentives for users by providing power to the grid during peak times. However, V2G systems are complex and costly to install, require advanced infrastructure, and can lead to increased battery wear due to frequent charging and discharging cycles. Additionally, user control may be limited compared to conventional smart charging systems, and participation depends on the availability of compatible vehicles and regulatory support.

Dynamic grid balancing in a private garage with a few cars offers several advantages, including optimizing energy use by adjusting charging times to avoid peak demand, which can lower electricity costs. It also ensures that the available electrical capacity is used efficiently, preventing overloads and reducing the risk of electrical issues. By managing the charging load dynamically, it can enhance the overall reliability and longevity of the home’s electrical system while supporting the integration of renewable energy sources, such as solar power, if available. Additionally, it provides flexibility in charging schedules, allowing for cost-effective charging during off-peak hours and potentially reducing energy expenses.

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So, which are the economic consequences for the EVs users and the grid operators of these three systems,

For the EV users

- **Smart Charging** provides notable economic benefits for EV users by enabling cost savings through scheduling charging during off-peak hours, which reduces electricity expenses. Users can also avoid grid overloads and associated infrastructure costs, leading to potential long-term savings. However, this system involves initial investment for advanced charging equipment and installation, which could offset some of the savings in the short term. Despite these upfront costs, the overall reduction in energy bills and improved efficiency can offer a positive return on investment over time.
- **Vehicle-to-Grid (V2G) systems** can economically benefit users by offering opportunities to earn income or receive incentives for supplying power back to the grid or participating in demand response programs. This revenue potential can help offset the higher costs associated with bidirectional charging equipment and infrastructure. However, the frequent charging and discharging required for V2G can lead to accelerated battery degradation, potentially increasing long-term costs due to battery replacement or reduced vehicle resale value. The initial investment and maintenance costs are also higher compared to conventional charging systems.
- **Dynamic Grid Balancing systems** offer economic advantages by optimizing energy use and avoiding peak electricity rates, which can lead to lower overall energy costs for users. By effectively managing the charging load, these systems help prevent electrical overloads and reduce the risk of costly repairs or upgrades to the home's electrical infrastructure. While the investment in dynamic management systems and smart infrastructure can be significant, the improved cost efficiency and reliability of the community 's electrical system can make it a worthwhile investment in the long run.

For the DSO Operator (GOPACS)

- **Smart Charging** offers economic advantages for grid operators like GOPACS by optimizing grid usage and reducing peak demand, which helps avoid expensive grid upgrades and mitigates the risk of grid overloads. By managing charging schedules to minimize peak load, smart charging can lower the overall cost of grid operations and improve efficiency. However, the integration of smart charging requires investment in advanced metering and control infrastructure, which may involve significant initial costs. Despite these costs, the long-term benefits of enhanced grid stability and reduced operational expenses can provide a favourable economic impact.
- **Vehicle-to-Grid (V2G) systems** can economically benefit grid operators by leveraging the stored energy in EVs to provide grid support services such as frequency regulation and demand response. This can help balance supply and demand, improve grid reliability, and reduce the need for additional generation capacity. V2G systems can also create new revenue streams through participation in ancillary services markets. However, the higher costs of installing bidirectional charging infrastructure and the potential for accelerated battery degradation can pose challenges. These factors require careful consideration to ensure that the economic benefits outweigh the investment and maintenance costs.

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- **Dynamic Grid Balancing systems** provide also economic benefits for grid operators by optimizing energy distribution and avoiding peak demand, which can reduce the need for expensive infrastructure upgrades and enhance grid stability. By managing the load dynamically, these systems help prevent overloads and improve the overall efficiency of grid operations. Although the implementation of dynamic load management systems involves upfront costs, the reduction in infrastructure strain and operational costs can make the investment worthwhile. The ability to balance loads effectively and integrate renewable energy sources further supports the economic viability of dynamic grid balancing in maintaining a cost-effective and reliable grid.

In Smart Charging and Dynamic Grid balancing, the power peaks are capped permitting a reduction in the power component of the electric tariff. In addition, the electric consumption is moved to periods with a lower tariff, representing an important cost reduction for the users' electric consumption. They can opt out but if not, they receive economic benefits from the technology with a very low economic impact and low impacts in the charging process .

In the Vehicle-to-Grid (V2G) systems, users must invest in the adaptation of the vehicles and chargers which are more expensive than in the previous case. They have the same advantages (less power, less price for the electricity), but at same time they can receive some extra incomes in exchange to their contribution as providers grid ancillary services. In addition, the battery can be degraded faster.

So, in summary the revenues model is the same in the first case and some incomes for the users can be obtained in the second.

The companies who charge the services will get similar benefits as they will adapt the tariffs to the costs keeping the margin equivalent.

3.3 Pricing strategy

The pricing strategy is focused on those who develop the software algorithm (Greenflux and Last Mile solutions). Their client will be GOPACS or any DSO or TSO equivalent. These operators receive lot of advantages from the control system, because for the same fleet of EVs, they can reduce the total power required representing lot of money in REs and Grid adaptations and in the second case (V2G) they can balance the grid, especially when Renewable is the major energy resource, using the EVs as cheap storage systems. Although they will receive less incomes, at same time they will pay less to the generators because they will be able to flatten de demand curve and will reduce the purchases in peak.

The price of the software as a service must offset the CAPEX invested, and the yearly OPEX. The DSO or TSO will reduce their investment requirements to compensate by far the cost of this service.

3.4 Financial model

In this UC1, some figures have been studied but the complete financial model was not implemented due to the difficulties of some calculations

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3.4.1 UC1a

3.4.1.1 Power savings

UC1a was implemented in Haarlem with 100 Charging Stations. However, we did a projection for the whole Utrecht area according to the estimations done in D9.2. The fleet of EVs (BEV and plug in) was estimated as follows ;

YEAR	Stock EVs	UTRECHT	Level 1 (2.4-7 kW)	Level 2 (7-22 kW)
2025	**55,122**	**2025**	1,194	190
2026	66,289	**2026**	1,409	224
2027	77,733	**2027**	1,625	258
2028	89,020	**2028**	1,834	292
2029	99,712	**2029**	2,031	323
2030	**109,370**	**2030**	2,207	351
2031	117,568	**2031**	2,358	375
2032	123,859	**2032**	2,475	394
2033	127,808	**2033**	2,553	406
2034	128,980	**2034**	2,584	411
2035	**126,929**	**2035**	2,562	408

The calculation of the total savings of power was estimated for year **2030**.

Table 1. Estimation of EVs and chargers' deployment in Utrecht

EVs and CPs in Utrecht		2030			
EVs in Utrecht		109,370	units		
Public Charging Points Utrecht 7 kW (AC)	1 EV	2,207	CPs 7 kW	**2,383**	**Chargers**
Public Charging Points 22 kW (AC)	2 EV	351	CPs 22 kW	702	CPs 11 kW
Total public CPs Utrecht		2,559	CPs	**2,910**	CPs (7k W, 11 kW)
EVs/CP		38	units		

Power savings 2030			
Periods of peak hours (17.00 h to 21.00 h)		4	hours
Charging occupancy in peak hours		80%	
Total maximum number of EVs charging publicly		**2,910**	EVs
Average number of vehicles charging in peak		2,328	EVs
Number of vehicles in 7 kW chargers in peak		1,766	EVs
Number of vehicles in 11 kW chargers in peak		562	EVs
% EVs charging publicly /Total EVs in Haarlem		2.1%	
Total power consumed globaly in peak hour		18,543	kW
Total power abated	17%	3,152	kW

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According to the UC1 team, approximately the 17% of the total power could be capped. The consumption in MWh was similar but moved to periods less costly. That represent around **3.15 MW** of savings if all the Utrecht fleet should have participated in the aggregation.

If we consider all the expenditure foreseen for Utrecht also calculated in D9.2 and we reduce the grid and REs investment in that 17%, the results reflect in 2030, **€7.03 Million of savings** and a total of €76 million in 11 years (from 2025 to 2035)

If we make the analysis of the energy consumed in the four hours of peak and consider the 7 kW proportion of chargers and those of 22 kW (2 * 11 kW), the results are as follows:

Total energy consumed by 7 kW chargers in peak	49.4 MWh/day	18,048 MWh/year
Total energy consumed by 22 kW chargers	24.7 MWh/day	9,025 MWh/year
Total energy consumed in peak	**74.2 MWh /day**	**27,073 MWh/year**

The next exercise was the calculation of the costs saved if the energy should have been consumed in a period different to those of peak. To do that the following table that shows the periods distribution (for Spain)

PENÍNSULA

MES	ENERO	FEBRERO	MARZO	ABRIL	MAYO	JUNIO	JULIO	AGOSTO	SEPTIEMBRE	OCTUBRE	NOVIEMBRE	DICIEMBRE	SÁBADOS, DOMINGOS Y FESTIVOS
0-1	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6
1-2	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6
2-3	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6
3-4	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6
4-5	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6
5-6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6
6-7	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6
7-8	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6	P6
8-9	P2	P2	P3	P5	P5	P4	P2	P4	P4	P5	P3	P2	P6
9-10	P1	P1	P2	P4	P4	P3	P1	P3	P3	P4	P2	P1	P6
10-11	P1	P1	P2	P4	P4	P3	P1	P3	P3	P4	P2	P1	P6
11-12	P1	P1	P2	P4	P4	P3	P1	P3	P3	P4	P2	P1	P6
12-13	P1	P1	P2	P4	P4	P3	P1	P3	P3	P4	P2	P1	P6
13-14	P1	P1	P2	P4	P4	P3	P1	P3	P3	P4	P2	P1	P6
14-15	P2	P2	P3	P5	P5	P4	P2	P4	P4	P5	P3	P2	P6
15-16	P2	P2	P3	P5	P5	P4	P2	P4	P4	P5	P3	P2	P6
16-17	P2	P2	P3	P5	P5	P4	P2	P4	P4	P5	P3	P2	P6
17-18	P2	P2	P3	P5	P5	P4	P2	P4	P4	P5	P3	P2	P6
18-19	P1	P1	P2	P4	P4	P3	P1	P3	P3	P4	P2	P1	P6
19-20	P1	P1	P2	P4	P4	P3	P1	P3	P3	P4	P2	P1	P6
20-21	P1	P1	P2	P4	P4	P3	P1	P3	P3	P4	P2	P1	P6
21-22	P1	P1	P2	P4	P4	P3	P1	P3	P3	P4	P2	P1	P6
22-23	P2	P2	P3	P5	P5	P4	P2	P4	P4	P5	P3	P2	P6
23-0	P2	P2	P3	P5	P5	P4	P2	P4	P4	P5	P3	P2	P6

Figure 1. Table with the distribution of tariff disaggregated by time and month (Energética corp)

The electricity cost term is included in the next table and also the tariff for those periods

Energy Term Cost			Energy price Energética.corp		
P1 Cost	0.091	€/kWh	P1 Tariff	0.270	€/kWh
P2 Cost	0.049	€/kWh	P2 Tariff	0.206	€/kWh
P3 Cost	0.029	€/kWh	P3 Tariff	0.166	€/kWh
P4 Cost	0.021	€/kWh	P4 Tariff	0.142	€/kWh
P5 Cost	0.002	€/kWh	P5 Tariff	0.109	€/kWh
P6 Cost	0.001	€/kWh	P6 Tariff	0.111	€/kWh

Table 3. electricity cost term and tariffs

An exercise was done to calculate the average costs and tariff if the period at peak hour should have been changed for another period before or after the peak as described in the

Peak hour		17-21 h
	Peak	After/before
January	P1	P2
Februar	P1	P3
March	P2	P5
April	P4	P5
June	P3	P4
July	P1	P2
August	P3	P4
Septemb	P3	P4
October	P4	P5
Novemb	P2	P3
Decemb	P1	P2

According to this calculation, the average cost of electricity moves from 54 €/MWh to 25 €/MWh if the peak period is moved to the immediate before or after periods.

The tariff (electricity price) moves from 361.6 € /MWh to 278.7€/MWh

Table 4. Effect in the period by Smart charging

3.4.1.2 Profit and losses

The next table represents the incomes of the CPO if no Smart Charging is applied

COST ANALYSIS FOR THE PEAK HOURS (4)				
No abatement, No VAT				
Variable Costs				**1,867,340 €**
Electricity cost peak	53.6	€/MWh	27,073	1,450,992 €
Chargers /T&D Var.	15.4	€/MWh	27,073	416,348 €
Fix Costs				**968,496 €**
O&M	287	€/year	2,383	684,101 €
Fix Power term (4 h)	79.6	€/year	2,383	189,662 €
General Expenses	7%			28,536 €
Depreciation (4/24)				66,196 €
TOTAL COSTS (2025, all chargers)				**2,835,836 €**
SELLING PRICE (No VAT)	361.6	€/MWh	27,073	**9,790,679 €**
EBITDA				**6,954,844 €**
				Benefit in peak hour (4 hours) without abatement

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According to the analysis of costs included in D9.4 for UC1a, the extra costs for the GOPACS service and Greenflux algorithm maintenance, raises 150,000 € per year. The next table represents the same yearly consumption for the whole fleet in Utrecht in 2030 but applying costs and tariffs of a cheaper period and adding the extra cost of GOPACS and Greenflux services.

COST ANALYSIS FOR THE PEAK HOURS (4)				
With abatement, No VAT				
Variable Costs				**1,084,457**
Electricity cost	**24.7**	€/MWh	27,073	668,109
Chargers /T&D Var.	15.4	€/MWh	27,073	416,348
Fix Costs				**968,496**
O&M	287	€/year	2,383	684,101
Fix Power term	79.6	€/year	2,383	189,662
General Expenses	7%			28,536
Depreciation (4/24)				66,196
Extra cost services Greenflux and Gopacs/year				**150,000**
TOTAL COSTS (2025, all chargers)				**2,202,953**
SELLING PRICE	**278.7**	€/MWh	27,073	**7,544,582**
EBITDA				**5,341,629**
			Benefit in peak hour (4 hours) with abatement	

Table 5. Estimation of incomes and costs for the whole Utrecht electric fleet with Smart Charging in year 2030

3.4.1.3 Results

From this analysis, we can see that citizens (EV users) will pay 7,544,582 - 9,790,679 €= **-2,246,097 €** less. At same time, the EBITDA is reduced for the DSO from 6,954,844 to 5,341,629 or **-1,613,214 €** less incomes.

If we intend to keep the same EBITDA in the peak hours without abatement, we should increase the selling prices to **338,3 €/MWh (or 59.6 €/MWh)** more but still bellow the **361.6 €/MWh** at peak hours.

This analysis is consistent with the INCIT EV ecosystem. On the other hand, when analysing smart charging at home/work for EV end users, it is also **a solution that reduces OPEX costs by 40-80%** when dynamic pricing is available. If smart charging is applied throughout the week (i.e. Sunday is statistically the day with lower spot prices), the savings and benefits for the grid and the end user can be even higher (up to 90%).

3.4.2 UC1b

3.4.2.1 Profit and losses

UC1b is more complex to estimate. As already mentioned, there are additional costs to consider (please check D9.4). There is an extra cost of 200 € to adapt each vehicle which is kept constant along the time, there

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is also an extra cost of 150 € per Charging Point in 2025 which is reduced overtime to 50 € /CP in 2030 and 25 € /CP in 2039. Thes two figures are considered CAPEX. In addition, there are some other costs considered OPEX reflected in the table below that sum up 650,000 € per year;

OPEX	2025
Extra costs Platform Goodmoovs/	150,000 €
Extra costs for the OCPP 2.0 Wedrivesolar	300,000 €
Extra costs of backoffice Last Mile Solutions	50,000 €
Extra costs for the communication system TOMP-API	50,000 €
Extra costs connection GPOPACS	100,000 €
TOTAL OPEX	**650,000 €**

Table 6. Extra OPEX to convert the whole EV fleet and CPs in Utrecht to V2G

This is reduced over time to reach 400,000 € in 2039 (15 years of lifetime).

If we calculate the OPEX, and the depreciation of the CAPEX multiplying the new CAPEX expenditure by the number of EVs and CPs in Utrecht during next years, a figure of around 1.5 million €/year will be the extra cost to apply this technology in all the Charging Points and EVs in Utrecht

YEARS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
TOTAL OPEX	650,000 €	500,000 €	450,000 €	425,000 €	410,000 €	400,000 €	400,000 €	400,000 €	400,000 €	400,000 €	400,000 €
TOTAL	748,810 €	913,556 €	1,088,504 €	1,227,874 €	1,371,915 €	1,587,082 €	1,649,910 €	1,690,133 €	1,720,622 €	1,741,988 €	1,811,314 €
EXTRA COSTS YEARLY	1,398,810 €	1,413,556 €	1,538,504 €	1,652,874 €	1,781,915 €	1,987,082 €	2,049,910 €	2,090,133 €	2,120,622 €	2,141,988 €	2,211,314 €

Table 7. Extra costs per year to convert all the EV fleet and CPs in Utrecht into V2G

Now, we must compare this figure to the same €7 million of savings for the DSO.

3.4.2.2 Results

The EV users will have to afford the extra costs to adapt to V2G their cars and also their linked CPs. Their batteries may suffer some degradation due to the extra charge and discharge processes. To offset these disadvantages, the CPO or the service provider must pay some money back to the EV owners if they accept the service. At home / office, the V2G business model will depend on the electricity tariff savings, depending on the country and the availability of dynamic pricing.

For the DSO, the advantages are higher than in the first Smart Charging process, as explained in the first subchapters.

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3.4.3 UC1c

Case UC1c, can be easily compared with case UC1a but at small scale. The proprietary of EVs in a private community or garage will be able to reduce their costs with an aggregate management. The business model for the service provider will be to estimate a fee to be paid by the users representing less money individually than the money saved by the service. This must be proven by the provider. The concept is similar to an ESCO (Community management of the energy of a building or industry by a professional service)

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4 USE CASE 2. DYNAMIC WIRELESS CHARGING LANE IN URBAN AREA

4.1 Description

4.1.1 UC2 description

In UC2, the objective is to apply DWPT and demonstrate the possibility to charge all types of urban vehicles in urban areas, offering a seamless experience to EV drivers, which would not need to worry about finding and driving towards available charging spots.

In the pilot, the e-corridor was 30 meters length, but the business model was design for a 500 m trench. This pilot system was prepared for 30 kW power transfer with a total capacity of 120 kW and ensure the possibility to charge all types of urban vehicles (PC, LCV, city logistics, small shuttle buses, large buses...). However, the business model was design for 400 kW total power.

4.1.2 Business case main assumptions UC2

Given the centric location of the charging system, it is reasonable that one vehicle could pass through this point several times per day, hence extending their autonomy. In the 500 m trench business model, it was considered two times crossing daily through the corridor. This would imply an extended range of 7 km before the required stop for full charging. The main assumptions were the following;

Year to start activities		**2035**	
Lifetime of equipment		15	years
Length of corridor		500	m
Charging process			
Average vehicle speed	**6.29** m/s	**22.6**	**km/h**
WPT Power		30	kW
Transmission efficiency		86%	%
Net power transferred		25.8	kW
Time to run 0.5 km (charging time)*2 times/day		2.65	min
Average EV consumption (Nissan Leaf electric)		17.1	kWh/100 km
Total energy charged in the corridor by one EV		1.14	kWh
Total extra autonomy with one charge event		6.7	km

Table 8. Main assumptions e-corridor in urban areas (UC2)
Yellow cells were used later for the sensitivity analysis

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With these initial assumptions, it was set the occupancy of the e-corridor daily and derived from it the total energy and power required to feed the corridor, providing the required energy for a number of vehicles crossing yearly. Charging cost is assumed as 10% more than conductive starting at 0,35 €/kWh in 2025.,

Charging capacity		
Separation between cars	1.5	m
Average lenght of car	4.8	m
Max. number of cars in corridor	**79**	EV/km
Number of active hours	12	h
Time to run the corridor	1.33	min
Total time between cars	5	sg
Max Number of cars per day	8,640	EV /day
% Occupancy 2030	10.0%	
Number of EV wireless per day	864	EV /day
% of EV Wireless/total EV 2030	0.9%	%
Total Energy consumed	1.1	MWh /day
Total Energy consumed	**418**	MWh /year
Total incomes by sales 2030	**135,518**	€/year
Total Power installed	0.26	MW

Table 9. UC2. Charging capacity, occupancy and energy needs, 2030

The benefits from the wireless infrastructure would be to offer fleet operators with lower cost vehicles, due to an important reduction of the battery size (around 20 kWh), which could bring the costs of the vehicles down to 27 % compared to the correspondent plug-in model, as well as reduce the dependence of the EV industry in critical materials such as lithium.

4.1.3 Key business roles

In this use case, public authorities play a critical role as they are the promoters of the project, whilst investors, and owners of the infrastructure could third parties acceding to a public bid. Typically, mobility planning supported by the DSS (and a cost-benefit analysis) would lead to the decision of investing in a DWPT infrastructure. The project tender would be published, and different packages would be granted to undertake the engineering phase, the procurement of the DWPT charging system and the electro-mobility service provision.

4.2 Revenue model

From the perspective of the asset owner and operator, the main source of revenue is the sale of electric energy (€/MWh), which is the key indicator that will be used in the financial models for the quantification and projection of future incomes. Nevertheless, it could also be suitable to charge for the usage time of the dynamic wireless charging lane or create more sophisticated revenue models with subscription options as well as different plans and value propositions for individuals and for professionals. To account for these factors, different assumptions are made in the revenue projections, including the number of cars that can be using simultaneously the dynamic wireless charging lane.

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4.3 Pricing strategy

The pricing strategy followed herein is based on the cost of electricity (fixed power concept and variable energy concept) for the asset owner who also acts as charging point operator in the model. To the cost, a margin is applied.

Although the current approach is reasonable, a more detailed pricing fixation analysis would be convenient in the future, quantifying the willingness to pay for the service provided.

4.4 Financial model UC2

4.4.1 Revenue projections UC2

The complete revenues' projection can be found in the Excel attached for UC2. These projections have been calculated for years 2030 and 2035, although 2035 is the year selected for the sensitivity analysis. The projection is made for 15 years by default which is the period set for the depreciation of the asset although it could be extended. The revenues are subject to be inflated (0% by default) and have been calculated out of VAT. In the initial assumptions, the number of EVs equipped with DWPT is being increased 1% from 2030 onward although the fare is also reduced 1% yearly. All these assumptions can be modified. There is a line for Grant (or any other incentive) initially set at zero.

REVENUES	2035	1	2	3	4	5
Flag 2035		1	1	1	1	1
Year		**2035**	**2036**	**2037**	**2038**	**2039**
Total Revenues	**€**	**134,626**	**134,449**	**134,271**	**134,094**	**133,917**
Sales of electricity without VAT	**€**	**134,626**	**134,449**	**134,271**	**134,094**	**133,917**
Fare (without VAT)	€/MWh	308.4	305.3	302.3	299.3	296.3
Volume	MWh	436	440	444	448	452
Grants		**0**	**0**	**0**	**0**	**0**

Table 10. UC2. Revenue model (year 2035, lifetime 15 years, partial data of first 5years)

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4.4.2 OPEX UC2

The OPEX table includes the total costs of goods sold (COGS) and General Expenses (SG&A). The COGS adds **fix costs** (operation and maintenance, other fix costs like the power component of the tariff and disposal costs) and **variable costs** (electricity costs, which depends on costs of electricity and volume, and other compensation costs). Electricity costs are reduced a 2% yearly due to the penetration of Renewables, although this variable can be modified. All the figures are out of VAT and are set with an inflation rate of 0% although this assumption can be also modified in the "Assumption tab". The OPEX table also shows the depreciation of the assets (including the upfront costs to manufacture the infrastructure (year 2034), the depreciation of the equipment for billing and communication (year 2035) and the renewal costs after 7 years with a value equivalent to 35 % of the initial upfront costs.

OPEX	2035					
		1	2	3	4	5
Flag 2035		1	1	1	1	1
Year		2,035	2,036	2,037	2,038	2,039
TOTAL COST OF GOODS SOLD	€	(72,596)	(71,688)	(70,798)	(69,924)	(69,067)
FIX COSTS		(42,322)	(41,475)	(40,646)	(39,833)	(39,036)
Operation Costs	€	(16,501)	(16,171)	(15,848)	(15,531)	(15,220)
Maintenace Costs	€	(19,542)	(19,151)	(18,768)	(18,392)	(18,025)
Other fix costs	€	(6,279)	(6,153)	(6,030)	(5,909)	(5,791)
Disposal Costs	€	-	-	-	-	-
VARIABLE COSTS		(29,119)	(29,081)	(29,042)	(29,004)	(28,966)
Electricity costs	E	(20,298)	(20,271)	(20,245)	(20,218)	(20,191)
Cost per unit	€/MWh	(46.50)	(46.04)	(45.58)	(45.12)	(44.67)
Volume	MWh	436	440	444	448	452
Compensation excedents in production (+)	€	(8,821)	(8,809)	(8,798)	(8,786)	(8,774)
Cost per unit	€/MWh	(20.2)	(20.0)	(19.8)	(19.6)	(19.4)
Volume	MWh /y	436	440	444	448	452
SG&A	€	(1,155)	(1,132)	(1,109)	(1,087)	(1,065)
Depreciation	€	(50,907)	(50,907)	(50,907)	(50,907)	(50,907)

Table 11. UC2. OPEX Costs 2035, lifetime 15 years, partial costs of first 5 years

4.4.3 Profit and losses UC2

This tab includes the profit and losses account (2035), till the "net incomes" line. No third parties financing is included, the "free cash flow", with the calculation of the NPV and the IRR, for a WACC of 6.5% equal for all the pilots to allow an easy comparison and the "taxes" table. The depreciation of the assets calculated in D9.4 and the corridor occupancy are the main factors affecting the profitability of the model.

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PROFIT AND LOSS ACCOU	2035							
				1	2	3	4	5
				1	1	1	1	1
YEAR		Total	2034	2035	2036	2037	2038	2039
Revenues Sales of electricity	€			134,626	134,449	134,271	134,094	133,917
Public grant	€			-	-	-	-	-
REVENUES	**€**	**1,736,350**	**-**	**134,626**	**134,449**	**134,271**	**134,094**	**133,917**
COGS	€			(72,596)	(71,688)	(70,798)	(69,924)	(69,067)
SG&A and other costs	€			(1,155)	(1,132)	(1,109)	(1,087)	(1,065)
EXPENSES	**€**	**(891,015)**	**-**	**(73,751)**	**(72,820)**	**(71,907)**	**(71,011)**	**(70,133)**
EBITDA	**€**	**845,335**	**-**	**60,875**	**61,629**	**62,364**	**63,083**	**63,784**
Depreciation and amortisation	€			(50,907)	(50,907)	(50,907)	(50,907)	(50,907)
EBIT	**€**	**845,335**	**-**	**9,968**	**10,722**	**11,458**	**12,176**	**12,877**
P&L interest expenses	€							
Taxes	€			(2,492)	(2,680)	(2,864)	(3,044)	(3,219)
Other	€							
Net Income / Loss	**€**	**(77,112)**	**-**	**7,476**	**8,041**	**8,593**	**9,132**	**9,658**
				5.55%	5.98%	6.40%	6.81%	7.21%

Free Cash Flow

YEAR		Total	2029	2030	2031	2032	2033	2034
Net Incomes	**€**		**-**	**7,476**	**8,041**	**8,593**	**9,132**	**9,658**
Depreciation and amortisation	€			50,907	50,907	50,907	50,907	50,907
CAPEX			(916,572)					
FREE CAS FLOW UNLEVELIZED	**€**		**(916,572)**	**58,383**	**58,948**	**59,500**	**60,039**	**60,565**

NPV	**-330,208 €**
IRR	**0.34%**
WACC	**6.5%**
Lifetime	**15**

Table 12. UC2. P&L year 2035 (lifetime 15 years, partial data for first 4 years)

4.4.4 Final Results

The summary of results is shown in the next table for infrastructure set up in years 2030 or 2035. Initial results reflect that in both case the IRR is far below the WACC. The solution is profitable with a **selling price of 0,49 €/kWh** in 2035, a 60% higher than a conductive (and static) charger of the same power.

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UC2 PARIS CENTRE. DYNAMIC WIRELESS POWER TRANSFER, 30 kW, 392 kW, 23 km/h, 500 m

Inductive

		2,030	2,035
P&L			
TOTAL Sales	€	135,518	134,626
TOTAL Expenses	€	(78,688)	(73,751)
EBITDA	€	56,830	60,875
NET INCOMES	€	548	7,476
KPIs			
NPV	€	(449,566)	(330,208)
IRR	%	-1.42%	0.34%
WACC	%	6.5%	6.5%
Lifetime		15	15
Inflation FLAG	NO		

Table 13. UC2. Results for years 2030 and 2035

4.4.5 Sensitivity

The sensitivity analysis allows to compare multi-variables or a couple of variables together and see how the NPV or the IRR evolve. This study may reflect how sensible is the model to the different factors. The calculation possibilities are enormous, so a combination of factors has been estimated that, in our opinion, are the most decisive in making the project profitable.

4.4.5.1 Multivariable Analysis

	Select Scenario		In Scenarios 2 to 4, play with the percentages, not numbers, in 5 to 7 modify numbers									
	1		1		2		3		4	5	6	7
Sensitivity 2035		UNITS	SCE base		SCE 2		SCE 3		SCE 4	SCE 4	SCE 4	SCE 4
COSTS												
CAPEX	**Don`t touch**											
CAPEX Charging Infrastructure	708,208	€	708,208	**-10%**	637,387	**10%**	779,029	**-10%**	637,387	708,208	708,208	708,208
CAPEX Renowal	242,969	€	242,969	**-10%**	218,672	**10%**	267,266	**-10%**	218,672	242,969	242,969	242,969
Lifetime of Equipment	15	Years	15		15		15		15	**15**	**15**	**15**
OPEX												
Operation Costs year 1	19,802	€/year 1	19,802	**-10%**	17,822	**10%**	21,782	**-10%**	17,822	19,802	19,802	19,802
Maintenance costs year 1	23,450	€/year 1	23,450	**-10%**	21,105	**10%**	25,795	**-10%**	21,105	23,450	23,450	23,450
Cost of electricity	55.80	€/MWh	55.80	**-10%**	50.22	**10%**	61.38	**-10%**	50.22	55.80	55.80	55.80
ECONOMIC INDEXES												
WACC	6.5%	%	6.5%	**0%**	6.5%	**0%**	6.5%	**0%**	6.5%	6.5%	6.5%	6.5%
Inflation prices	0.0%	%	0.0%	**0%**	0.0%	**0%**	0.0%	**0%**	0.0%	0.0%	1.5%	2.0%
Inflation costs	0.0%	%	0.0%	**0%**	0.0%	**0%**	0.0%	**0%**	0.0%	0.0%	2.0%	1.5%
% SG&A and other costs /labour OPEX	7.0%	%	7.0%	**0%**	7.0%	**0%**	7.0%	**0%**	7.0%	7.0%	7.0%	7.0%
OTHER FACTORS												
LOCATION												
Percentage of occupancy over maximum	10.0%	%	10.0%	**-10%**	9.0%	**10%**	11.0%	**10%**	11.0%	10.0%	10.0%	10.0%
Transmission efficiency	86.0%	%	86.0%	**-10%**	77.4%	**10%**	94.6%	**10%**	94.6%	86.0%	86.0%	86.0%
Nª Active hours	10	Veh	10	**-10%**	9	**10%**	11	**10%**	11	10	10	10
PRICES												
Conductive Electricity Tariff price	308.43	€/Mwh year 1	308.43	-10%	277.58	10%	339.27	**10%**	339.27	308.43	308.43	308.43
Factor (Inductive/Conductive)	1.2	Tariff Ind/Con	1.2	0%	1.2	0%	1.2	**10%**	1.3	1.2	1.3	1.3
Grant over sales of electricity	0.0%	%	0.0%	0%	0.0%	0%	0.0%	**0%**	0.0%	5.0%	0.0%	**5.0%**
RESULTS												
NPV	(330,208)	€	(330,208)		(394,051)		(244,987)		95,300	(275,161)	(213,977)	(153,061)
IRR (post tax)	**0.34%**	%	0.34%		**-2.15%**		**2.54%**		**8.21%**	**1.50%**	**2.72%**	**3.84%**

Table 14. UC2. Multivariable Analysis

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The scenarios prepared have been the following:

Scenario 1. The conditions are those of the base case in year 2035. IRR reflects 0.34 % below the WACC

Scenario 2. CAPEX and OPEX are decreased 10% and occupancy, efficiency and active hours are also decreased a 10%. The result is worst with an IRR of -2.15 %

Scenario 3. CAPEX and OPEX are increased 10% and occupancy, efficiency and active hours are also increased a 10%. The result is better with an IRR of 2.54 % although still below the WACC.

Scenario 4. CAPEX and OPEX are decreased 10% but occupancy, efficiency and active hours are increased a 10%. The result is clearly above the WACC with an IRR of 8.21%

Scenario 5. Same conditions than scenario 1, but a 5% of grant over the electricity revenues, deriving in a 1.50 % IRR.

Scenario 6. Same conditions than scenario 1 but increasing prices of electricity by a factor of 1.3 (10% higher price for wireless than the equivalent for conductive). IRR 2.72%

Scenario 7. Same conditions than scenario 1 but increasing prices of electricity by a factor of 1.3 (10% higher price for wireless than the equivalent for conductive) and providing a grant of 5% over the electricity revenues. IRR over the WACC 3.84 %.

4.4.5.2 Dual variable Analysis

For the dual variable analysis, two factors are selected and modified a 10% and 15% up and down. Then, the sensitivity is applied, and the IRR is modified for each couple of values. A color code reflects the results; the greener the most profitable, the red the less.

The following comparisons have been implemented:

Analysis 1. CAPEX versus conductive prices. Wireless prices are those for conductive equivalent power values, multiplied by a factor that it is 1 by default. Usually, wireless prices per MWh should be slightly over those for conductive.

	SCEN	1			CAPEX		
	IIR	**0.34%**	814,439 €	779,029 €	**708,208 €**	637,387 €	601,977 €
		354.7 €	2.28%	2.70%	3.48%	4.39%	4.90%
		339.3 €	1.28%	1.70%	2.59%	3.45%	3.95%
Conductive		**308.4 €**	-0.87%	-0.49%	0.34%	1.26%	1.76%
Prices		339.3 €	1.28%	1.70%	2.59%	3.45%	3.95%
		262.2 €	-5.05%	-4.67%	-3.86%	-2.96%	-2.47%

Table 15. UC2 Dual Analysis. CAPEX versus Prices

Electricity prices can modify greatly the results. A 15% up in prices provides an 3.48% IRR with the same CAPEX.

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Analysis 2. CAPEX versus Grant over revenues

	SCEN	1	CAPEX				
	IIR	0.34%	814,439 €	779,029 €	**708,208 €**	637,387 €	601,977 €
		6.60%	0.59%	0.99%	1.86%	2.83%	3.26%
		5.50%	0.35%	0.75%	1.62%	2.57%	3.10%
Grant over sales		**5.00%**	0.25%	0.65%	1.50%	2.46%	2.98%
		4.50%	0.14%	0.54%	1.39%	2.34%	2.86%
		4.00%	0.03%	0.42%	1.28%	2.22%	2.74%

Table 16.UC2 Dual Analysis. CAPEX versus Grant

The impact of the Grants is not so acute with an slight increase of WACC over the situation of no grant.

Analysis 3. CAPEX versus maintenance costs

	SCEN	1	CAPEX				
	IIR	0.34%	814,439 €	779,029 €	708,208 €	637,387 €	601,977 €
		26,967.5	-1.31%	-0.93%	-0.12%	0.79%	1.28%
		25,795.0	-1.16%	-0.78%	0.04%	0.95%	1.44%
Maintenance Cost		23,450.0	-0.87%	-0.49%	0.34%	1.26%	1.76%
		25,795.0	-1.16%	-0.78%	0.04%	0.95%	1.44%
		19,932.5	-0.44%	-0.05%	0.79%	1.72%	2.23%

Table 17. UC2 Dual analysis. CAPEX versus maintenance costs

The impact of the Maintenance cost is not so acute with an slight increase of WACC over the situation of initial maintenance figure if you reduce a 15% the maintenance costs.

Analysis 4. CAPEX versus occupancy of e-corridor

	SCEN	1	CAPEX				
	IIR	**0.34%**	814,439 €	779,029 €	**708,208 €**	637,387 €	601,977 €
		11.5%	1.80%	2.22%	3.00%	3.93%	4.42%
		11.0%	0.95%	1.35%	2.23%	3.11%	3.61%
Occupancy		**10.0%**	-0.87%	-0.49%	0.34%	1.26%	1.76%
		11.0%	0.95%	1.35%	2.23%	3.11%	3.61%
		8.5%	-4.18%	-3.79%	-2.95%	-2.04%	-1.59%

Table 18. UC2. Dual Analysis. CAPEX versus Occupancy

Occupancy of the e-corridor is key. An increase of 15% of occupancy moves the WACC from 0.34 % to 3 % with the same CAPEX. If the CAPEX is reduced a 15%, the WACC can rise to 4.42%.

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5 USE CASE 3. DYNAMIC WIRELESS CHARGING FOR LONG DISTANCE (PROTOTYPE E-ROAD)

5.1 Description

5.1.1 UC description

The objective of UC3 is to demonstrate the reliability and interoperability of DWPT for long distance and high-speed lanes (90 km/h) in all relevant vehicle dimensions (DWPT system, car, use case, etc.). The range of power transference will reach 90 kW.

The main specificity of the high-speed use case is the fact that the energy transmitted per km is significantly smaller than for the urban lower speed use case. A second specificity is the road surface requirements in terms of continuity which reduces the number of road integration process possibilities. A third specificity is the absence of frequent intersections. In summary, the road surface must be continuing maybe with a dedicated e-lane, at least initially with sufficient length to charge enough extra autonomy. The number of vehicles charging simultaneously is another variable that should be quantified that probably, will require autonomous driving through the e-corridor.

5.1.2 Business case

INCIT-EV has prepared a demonstration in a controlled area (Vedecom facilities) of an e-lane to simulate the performance and advantages of DWPT in highway conditions, which will extend the autonomy of EVs and thus support long range travels. A full- scale business case has been prepared for a 25-km DWPT track, which will lead to an extended autonomy of 120 km. The specificities of long-distance road conditions may allow higher charging capacity (power) and less cost infrastructure cost per km (longer elementary segments) than in urban environment. This is also due to the cheapest costs of terrain in the periphery of the cities. In addition, it will be needed an access point to the medium power grid and/or in the best case, to a dedicated REs installation in the surroundings. The main assumptions for the business model are described below:

Year to start activities		**2035**	
Lifetime of equipment		15	years
Charging process			
Lenght of corridor		**25**	**km**
Average vehicle speed	**25.00** m/s	**90.0**	**km/h**
WPT Power		90	kW
Transmission efficiency		82%	%
Net power transferred		73.8	kW
Time to run 25 km (charging time)		16.67	min
Average EV consumption (Nissan Leaf electric)		17.1	kWh/100 km
Total energy charged in the corridor by one EV		20.50	kWh
Total extra autonomy with one charge event		120	km

Table 19. Main assumptions e-corridor in urban areas (UC3).
Yellow cells are used later for the sensitivity analysis

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With these initial assumptions, it was set the occupancy of the e-corridor daily and derived from it the total energy and power required to feed the corridor, providing the required energy for several vehicles crossing yearly. The occupancy was set at 5%, 10% less than inside the city. The reason is that we do not expect a great use of these e-corridors during working days although it will be probably full-on vacations and weekends. If a real application is implemented in the future, we will be able to refine this percentage.

Charging capacity for 2030			
Separation between cars	75.0	m	
Average lenght of car	4.8	m	
Max. number of cars in 25 km	**313**	EV/25 km	
Number of active hours	10	h	
Time to run 25 Km	16.67	min	
Total time between cars	3.19	sg	
Max Number of cars per day	11,278	EV /day	
% Occupancy 2030	5%		
Number of EV wireless per day	**564**	EV /day	
EVs in Paris (2035)	186,000	EVs	
% of EV Wirel/total EV 2035	0.3%	%	
Total Energy consumed	14.1	MWh /day	
Total Energy consumed	**5,146**	MWh /year	
Total incomes by sales 2030	**2,317,848**	€/year	VAT excl.
Total Power installed	1.42	MW	

Table 20. UC3. Charging capacity, occupancy and energy needs, 2030

The benefits from the wireless infrastructure would be to offer fleet operators with lower cost vehicles, due to an important reduction of the battery size (around 20 kWh), which could bring the costs of the vehicles down to 25 % compared to the correspondent plug-in model, as well as reduce the dependence of the EV industry in critical materials such as lithium. However, it is not clear that end-user will prefer reducing battery size and autonomy, to gaining a limited extension of the autonomy only in a short number of e-lanes in the highways around the Paris city.

5.1.3 Key business roles

Unlike UC2, where public authorities play the role of promoters and maybe investors, in this scenario those roles will be likely assumed in most cases by the private sector through a public auction, specifically the Motorway companies/operators. They will probably manage all he services subcontracting telecom operators and electric utilities and investing in the coils, and power electronics, and undertaking the construction of the DWPT lane. That package could be offered as a service to the electro-mobility providers that would be responsible for the service, payment charge and support to the end users. The contract with the Administrations will be in the form of a concession for several years. The main concern will be to align the EVs' OEMs with the Motorway operators. A substantial number of EVs mut be equipped with DWPT capacities before the Motorways construction companies decide to invest in this technology.

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5.2 Revenue model

As in the previous UC, from the perspective of the asset owner and operator, the main source of revenue is the sale of electric energy (€/MWh), which is the key indicator that will be used in the financial models for the quantification and projection of future incomes. Nevertheless, it could also be suitable to charge for the usage time of the dynamic wireless charging lane or create more sophisticated revenue models with subscription options as well as different plans and value propositions for individuals and for professionals. To account for these factors, different assumptions are made in the revenue projections, including the number of cars that can be using simultaneously the dynamic wireless charging lane.

5.3 Pricing strategy

The pricing strategy is, as in the urban dynamic charging infrastructure, based on the cost of electricity (fixed power concept and variable energy concept) for the asset owner who also acts as charging point operator in the model. To the cost, a margin is applied.

Although the current approach is reasonable, a more detailed pricing fixation analysis would be convenient in the future, quantifying the willingness to pay for the service provided.

If this model is pursuit, a dedicated lane should be created in the private highways at least at the beginning because the cars must be perfectly aligned to the coils line and the distances between successive cars must be respected to allow a perfect charging process. That will probably require autonomous driving. The price will be charged automatically when transit and this price will be probably much higher than a conventional ultrafast charger because the total investment in this solution will be high and the overall depreciation of assets will impact a lot in the model. The key element to reach the breakeven point will be as in the rest of cases, the occupancy over the maximum capacity.

5.4 Financial model UC3

5.4.1 Revenue projections UC3

The complete revenues' projection can be found in the Excel attached for UC3. These projections have been calculated for years 2030 and 2035, although 2035 is the year selected for the sensitivity analysis. The projection is made for 15 years by default which is the period set for the depreciation of the asset although it could be extended. The revenues are subject to be inflated (0% by default, but can be modified in the assumptions' tab) and have been calculated out of VAT. In the initial assumptions, the number of EVs equipped with DWPT is being increased 1% from 2030 onward although the fare is also reduced 1% yearly. All these assumptions can be modified. There is a line for Grant (or any other incentive) initially set at zero.

We do believe, that if this system is adopted, a certain level of A certain level of public aid should be guaranteed.

Below the revenues projections for year 2035 when the technology will be matured enough.

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REVENUES		2035	1	2	3	4	5
Flag 2030			1	1	1	1	1
Year			2035	2036	2037	2038	2039
Total Revenues	**€**		**2,316,689**	**2,316,457**	**2,316,226**	**2,315,994**	**2,315,762**
Sales of electricity without VAT	**€**		**2,316,689**	**2,316,457**	**2,316,226**	**2,315,994**	**2,315,762**
Fare (without VAT)	€/MWh		428.4	424.1	419.8	415.6	411.5
Volume	MWh		5,408	5,462	5,517	5,572	5,628
Grants	**€**		**0**	**0**	**0**	**0**	**0**

Table 21. UC3. Revenue model (year 2035, lifetime 15 years, partial data of first 5 years)

5.4.2 OPEX projections UC3

The OPEX table includes the total costs of goods sold (COGS) and General Expenses (SG&A). The COGS adds fix costs (operation and maintenance, other fix costs like the power component of the tariff and disposal costs) and variable costs (electricity costs, which depends on costs of electricity and volume, and other compensation costs). Electricity costs are reduced a 2% yearly due to the penetration of Renewables, although this variable can be modified. All the figures are out of VAT and are set with an inflation rate of 0% although this assumption can be also modified in the "Assumption tab". The OPEX table also shows the depreciation of the assets (including the upfront costs to manufacture the infrastructure (year 2034), the depreciation of the equipment for billing and communication (year 2035) and the renewal costs after 7 years with a value equivalent to 35 % of the initial upfront costs.

OPEX		2035	1	2	3	4	5
Flag 2035			1	1	1	1	1
Year			2,035	2,036	2,037	2,038	2,039
TOTAL COST OF GOLDS SOLD	**€**		**(652,534)**	**(647,098)**	**(641,770)**	**(636,548)**	**(631,429)**
FIX COSTS			**(260,379)**	**(255,172)**	**(250,068)**	**(245,067)**	**(240,166)**
Operation Costs	**€**		**(135,859)**	**(133,142)**	**(130,479)**	**(127,870)**	**(125,312)**
Maintenace Costs	**€**		**(90,392)**	**(88,584)**	**(86,813)**	**(85,076)**	**(83,375)**
Other fix costs			**(34,128)**	**(33,446)**	**(32,777)**	**(32,121)**	**(31,479)**
Disposal costs	**€**		-	-	-	-	-
VARIABLE COSTS			**(382,644)**	**(382,606)**	**(382,568)**	**(382,530)**	**(382,491)**
Electricity costs	**€**		**(251,495)**	**(251,469)**	**(251,444)**	**(251,419)**	**(251,394)**
Cost per unit	€/MWh		(46.50)	(46.04)	(45.58)	(45.12)	(44.67)
Volume	MWh		5,408	5,462	5,517	5,572	5,628
Compensation excedents in production (+)	**€**		**(131,150)**	**(131,137)**	**(131,124)**	**(131,110)**	**(131,097)**
Cost per unit	€/MWh		(24.3)	(24.0)	(23.8)	(23.5)	(23.3)
Volume	MWh /y		5,408	5,462	5,517	5,572	5,628
SG&A	**€**		**(9,510)**	**(9,320)**	**(9,134)**	**(8,951)**	**(8,772)**
Depreciation	**€**		**816,261**	**816,261**	**816,261**	**816,261**	**816,261**
Lifetime		15					

Table 22. UC3. OPEX Costs 2035. Lifetime 15 years, partial costs of first 5 years

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5.4.3 Profit and losses UC3

This tab includes the profit and losses account (2035), till the “net incomes” line. No third parties financing is included, the “free cash flow”, with the calculation of the NPV and the IRR, for a WACC of 6.5% equal for all the pilots to allow an easy comparison and also the “taxes” table. The depreciation of the assets calculated in D9.4 and the corridor occupancy are the main factors affecting the profitability of the model.

PROFIT AND LOSS ACCOUNT	2035		1	2	3	4	5
			1	1	1	1	1
YEAR		**2034**	**2035**	**2036**	**2037**	**2038**	**2039**
Revenues Sales of electricity	€		2,316,689	2,316,457	2,316,226	2,315,994	2,315,762
Public grant	€		-	-	-	-	-
REVENUES	**€**	**-**	**2,316,689**	**2,316,457**	**2,316,226**	**2,315,994**	**2,315,762**
COGS	€		(652,534)	(652,534)	(652,534)	(652,534)	(652,534)
SG&A and other costs	€		(9,510)	(9,320)	(9,134)	(8,951)	(8,772)
EXPENSES	**€**	**-**	**(662,044)**	**(661,854)**	**(661,668)**	**(661,485)**	**(661,306)**
EBITDA	**€**	**-**	**1,654,645**	**1,654,603**	**1,654,558**	**1,654,509**	**1,654,457**
Depreciation and amortisation	€		(816,261)	(816,261)	(816,261)	(816,261)	(816,261)
EBIT	**€**	**-**	**838,384**	**838,342**	**838,297**	**838,248**	**838,195**
P&L interest expenses	€						
Taxes	€		(209,596)	(209,586)	(209,574)	(209,562)	(209,549)
Other	€						
Net Income / Loss	**€**	**-**	**628,788**	**628,757**	**628,723**	**628,686**	**628,647**
			27.14%	27.14%	27.14%	27.15%	27.15%

Free Cash Flow

YEAR		**2034**	**2035**	**2036**	**2037**	**2038**	**2039**
Net Incomes	**€**	**-**	**628,788**	**628,757**	**628,723**	**628,686**	**628,647**
Depreciation and amortisation	€		816,261	816,261	816,261	816,261	816,261
CAPEX		(14,073,185)					
FREE CAS FLOW UNLEVELIZED	**€**	**(14,073,185)**	**1,445,049**	**1,445,018**	**1,444,984**	**1,444,947**	**1,444,908**

NPV	**-488,159 €**
IIR	**6.0%**
WACC	**6.5%**
Lifetime	**15**

Table 23. UC3. P&L year 2035 (lifetime 15 years, partial data for first 5 years)

5.4.4 Final Results UC3

The summary of results is shown in the next table for infrastructure set up in years 2030 or 2035. Initial results reflect that in both case the IRR is far below the WACC, indicating the difficulties to make this solution profitable. The result is worse than in the urban solution. Profitability starts at a minimum **selling price of 0,53 €/kWh in 2035**, a 25% higher than a conductive charger of the same power.

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UC3 PARIS PERIPHERY. DYNAMIC WIRELESS POWER TRANSFER, 1.42 MW, 90 kW, 90km/h, 25 km

Inductive

		2,030	2,035
P&L			
TOTAL Sales	€	2,317,848	2,316,689
TOTAL Expenses	€	(691,933)	(662,044)
EBITDA	€	1,625,914	1,654,645
NET INCOMES	€	548,695	628,788
KPIs			
NPV	€	(1,678,245)	(488,159)
IRR	%	4.89%	5.96%
WACC	%	6.5%	6.5%
Lifetime		15	15
Inflation FLAG	NO		

Table 24. UC3. Results for years 2030 and 2035

5.4.5 Sensitivity

The sensitivity analysis allows to compare multi-variables or a couple of variables together and see how the NPV or the IRR evolve. This study may reflect how sensible is the model to the different factors. The calculation possibilities are enormous, so a combination of factors has been estimated that, in our opinion, are the most decisive in making the project profitable.

5.4.5.1 Multivariable Analysis

Select Scenario — In Scenarios 2 to 4, play with the percentages, not numbers, in 5 to 7 modify numbers

UC3. Sensitivity 2035	1	UNITS	1 SCE base		2 SCE 2		3 SCE 3		4 SCE 4	5 SCE 4	6 SCE 4	7 SCE 4
COSTS												
CAPEX	Don`t touch											
CAPEX Infrastructure	12,311,416	€	12,311,416	-10%	11,080,275	10%	13,542,558	-10%	11,080,275	12,311,416	12,311,416	12,311,416
CAPEX Renewal	3,849,468	€	3,849,468	-10%	3,464,521	10%	4,234,415	-10%	3,464,521	3,849,468	3,849,468	3,849,468
Lifetime of Equipment	15	Years	15		15		15		15	15	15	15
OPEX												
Operation Costs year 1	163,031	€/year 1	163,031	-10%	146,728	10%	179,334	-10%	146,728	163,031	163,031	163,031
Maintenance costs year 1	108,470	€/year 1	108,470	-10%	97,623	10%	119,318	-10%	97,623	108,470	108,470	108,470
Cost of electricity	55.80	€/MWh	55.80	-10%	50.22	10%	61.38	-10%	50.22	55.8	55.8	55.8
ECONOMIC INDEXES												
WACC	6.5%	%	6.5%	0%	6.5%	0%	6.5%	0%	6.5%	6.5%	6.5%	6.5%
Inflation prices	0.0%	%	0.0%	0%	0.0%	0%	0.0%	0%	0.0%	0.0%	1.5%	2.0%
Inflation costs	0.0%	%	0.0%	0%	0.0%	0%	0.0%	0%	0.0%	0.0%	2.0%	1.5%
% SG&A and other costs /labour OPEX	7.0%	%	7.0%	0%	7.0%	0%	7.0%	0%	7.0%	7.0%	7.0%	7.0%
OTHER FACTORS												
LOCATION												
Percentage of occupancy over maximum	5.0%	%	5.0%	-10%	4.5%	10%	5.5%	10%	5.5%	5.0%	5.0%	5.0%
Transmission efficiency	82.0%	%	82.0%	-10%	73.8%	10%	90.2%	10%	90.2%	82.0%	82.0%	82.0%
Nª Active hours	10	h	10	-10%	9	10%	11	10%	11	10	10	10
PRICES												
Conductive Electricity Tariff price	428.37	€/Mwh year 1	428.37	-10%	385.53	10%	471.21	10%	471.21	428.37	428.37	428.37
Factor (Inductive/Conductive)	1.2	Tariff Ind/Cond	1.2	0%	1.2	0%	1.2	10%	1.3	1.2	1.3	1.3
Grant over sales of electricity	0.0%	%	0.0%	0%	0.0%	0%	0.0%	0%	0.0%	5.0%	0.0%	5.0%
RESULTS												
NPV	(488,159)	€	(488,159)		(2,766,393)		2,607,836		7,992,760	328,637	1,323,878	2,352,662
IRR (post tax)	5.96%	%	5.96%		2.89%		9.03%		15.30%	6.86%	7.93%	9.01%

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Table 25. UC3. Multivariable Analysis

The scenarios prepared have been the following:

Scenario 1. The conditions are those of the base case in year 2035. IRR reflects **5.96 %** below the WACC (6.5%) but better than in the urban case (IRR UC2 was 0.34%)

Scenario 2. CAPEX and OPEX are decreased 10% and occupancy, efficiency and active hours are also decreased a 10%. The result is worst with an IRR of 2.89 %

Scenario 3. CAPEX and OPEX are increased 10% and occupancy, efficiency and active hours are also increased a 10%. The result is better with an IRR of 9.03 % over the WACC.

Scenario 4. CAPEX and OPEX are decreased 10% but occupancy, efficiency and active hours are increased a 10%. The result is above the WACC with an IRR of 15.30%, a relatively good profitability to invest (high risk of losses).

Scenario 5. Same conditions than scenario 1, but a 5% of grant over the electricity revenues, deriving in a 6.86 % IRR.

Scenario 6. Same conditions than scenario 1 but increasing prices of electricity by a factor of 1.3 (10% higher price for wireless than the equivalent for conductive). IRR 7.93%

Scenario 7. Same conditions than scenario 1 but increasing prices of electricity by a factor of 1.3 (10% higher price for wireless than the equivalent for conductive) and providing a grant of 5% over the electricity revenues. IRR over the WACC 9.31 %.

UC3 provides best figures than UC2, this is mainly due to the higher prices due to higher power level and less competency.

5.4.5.2 Dual variable Analysis

For the dual variable analysis, two factors are selected and modified a 10% and 15% up and down. Then, the sensitivity is applied, and the IRR is modified for each couple of values. A color code reflects the results; the greener the most profitable, the red the less.

The following comparisons have been implemented:

Analysis 1. CAPEX versus conductive prices. Wireless prices are those for conductive equivalent power values, multiplied by a factor that it is 1 by default. Usually, wireless prices per MWh should be slightly over those for conductive.

	SCEN	1			CAPEX		
	IRR	**5.96%**	14,158,129 €	13,542,558 €	**12,311,416 €**	11,080,275 €	10,464,704 €
		492.6 €	6.76%	7.29%	8.46%	9.81%	10.57%
		471.2 €	6.00%	6.51%	7.64%	8.95%	9.68%
Conductive		**428.4 €**	4.43%	4.91%	5.96%	7.16%	7.83%
Prices		385.5 €	2.77%	3.21%	4.17%	5.28%	5.89%
		364.1 €	1.90%	2.32%	3.24%	4.29%	4.88%

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Table 26. UC3. Dual analysis. CAPEX versus Prices

The model is very sensible to electricity prices. However, any increase in prices will probably impact a lot on the number of users as there are other cheaper options for charging. This behaviour has not been measured in INCIT-EV.

Analysis 2. CAPEX versus Grant over revenues

	SCEN	1			CAPEX		
	IRR	5.96%	14,158,129 €	13,542,558 €	**12,311,416 €**	11,080,275 €	10,464,704 €
		6.60%	5.54%	6.04%	7.15%	8.42%	9.13%
		5.50%	5.36%	5.85%	6.95%	8.21%	8.92%
Grant over sales		**5.00%**	5.28%	5.77%	6.86%	8.12%	8.82%
		4.50%	5.19%	5.68%	6.77%	8.02%	8.72%
		4.00%	5.11%	5.60%	6.68%	7.93%	8.63%

Table 27. UC3. CAPEX and Grant

A 5% of grant raises the IRR from 5.96% to 7.15%.

Analysis 3. CAPEX versus maintenance costs

	SCEN	1			CAPEX		
	IRR	5.96%	14,158,129 €	13,542,558 €	12,311,416 €	11,080,275 €	10,464,704 €
		124,741.1	4.33%	4.81%	5.85%	7.05%	7.72%
		119,317.5	4.37%	4.84%	5.88%	7.08%	7.76%
Maintenance Cost		108,470.5	4.43%	4.91%	5.96%	7.16%	7.83%
		97,623.4	4.50%	4.98%	6.03%	7.24%	7.91%
		92,199.9	4.53%	5.01%	6.06%	7.27%	7.95%

Table 28. UC3. CAPEX versus maintenance costs.

The impact of the Maintenance cost is not so acute with a slight increase of WACC over the situation of initial maintenance figure if you reduce a 15% the maintenance costs 6.06 % for the same CAPEX)

Analysis 4. CAPEX versus occupancy of e-corridor

	SCEN	1			CAPEX		
	IRR	**5.96%**	14,158,129 €	13,542,558 €	**12,311,416 €**	11,080,275 €	10,464,704 €
		5.8%	6.46%	6.99%	8.14%	9.47%	10.22%
		5.5%	5.80%	6.31%	7.43%	8.72%	9.44%
Occupancy		**5.0%**	4.43%	4.91%	5.96%	7.16%	7.83%
		4.5%	3.00%	3.44%	4.41%	5.53%	6.15%
		4.3%	2.25%	2.67%	3.61%	4.68%	5.28%

Table 29. UC3. CAPEX versus Occupancy

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Occupancy impacts substantially in results but also the CAPEX reduction.

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6 USE CASE 4. CHARGING HUB IN A PARK-AND-RIDE FACILITY

6.1 Description

6.1.1 UC4 description

The aim of UC4 is to test a smart micro-grid, including several DC charging stations with different technologies and performances, powered by the tramway DC network. The test field also integrates the facilities and the knowledge developed in previous projects.

The main objective is to prove that there are alternatives to redundant, expensive, and often not practicable solutions for the meticulous infrastructural updates needed in order to improve both the number of charging points as well as the average power outputs of urban charging infrastructures. Using the available power provided by the conversion substations is one of the smarter solutions out there.

The Park and Ride facility is one of the most promising solutions according to the project team preparing this deliverable. There is an increasing trend to protect citizens against pollution, noise, etc, inside the cities and also gaining space for pedestrians reducing the parking slots in surface and the circulation of vehicles with more green areas and roads only for pedestrian. In D9.2 all these trends were described in detail.

In the opinion of the authors, the ban of ICE cars in 2035 will be difficult to comply, especially for the people with less economic resources that moves from the periphery to the city center in a daily commuting, cannot afford an electric car (25% more expensive) and has not private garages to own a low charger in property. The Park and Ride facilities could be hubs to interchange the means of transport from ICE to EV rental or sharing, also, a place to get access to public transportation (electric bus, train or tramp), or a place to install proximity parkings to leave the ICE car there and substitute by a clean solution to enter into the city, including light vehicles (bikes and e-bikes, quadricycles, e-scooters, etc) for young people. The offer can be improved also with Commercial shops, restaurants, etc

These places should guarantee an easy interoperability among the different moving options, (a single card or app for everything). A team of operators should charge incoming electric cars using ultrafast chargers if possible and other types of slow chargers for light vehicles. This will guarantee occupancy/rotation. Rented or shared EVs will leave the Park and Ride facilities in the early morning and come back later, after the working hours, reducing O&M costs. The facilities should be placed in the periphery of the cities beside the large highways or roads that leaves the cities. The places will also give service to tourist or professionals making commercial missions among cities.

In this sense, the ICE cars' ban could be only applied initially inside the large cities, allowing the circulation of these cars during some time outside them until costs are reduced to the level of the ICE cars and charging solutions are available for all.

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6.1.2 Business case UC4

Thanks to the connection with the tramway network, new business models can be tested (i.e. involving the public transport operator) allowing to reduce the prices for the final users and to foster the use of public-transport to get into the city.

Moreover, the development of new, collaborative business models can increase the integration and data exchange between different involved actors (i.e. Municipality, public transport operator, carsharing services, power grid management, etc.), paving the way for future improvements and applications.

The pilot analysed is limited to a 150 kW fast bidirectional charger and two DC/AC 3.6 kW also bidirectional. Although this is just a portion of the overall business case (explained before), the hub provides yet positive figures (due to the expected occupancy).

The analysis has been divided in two blocks; block 1, ultrafast charger and block 2 Slow 3.6 kW chargers. The main assumptions have been the following:

Superfast Charger 150 kW			2 Slow charger 3.6 kW		
Average charging time	30	minutes	600	minutes	10 h
Charging capacity	150	kW	3.6	kW	
Maximum charging events per day	20	events	2	events	
Efficiency of location	70%	%	75%	%	
Achievable charging events per day	14	events/day	1.5	events/day/charger	
Achievable charging events per yea	5,110	events/year	548	events/year/charger	
Efficiency Charging process	92%	%	92%	%	
Total kWh storaged in one charging	69	kWh	33	kWh	
Total kWh for 100 km	18	kWh	18	kWh	
Total autonomy with one charge ev	383	km	184	km/charge	

Table 30. UC4. Main assumptions Park and ride hub

The efficiency of locations represents the time that the EV are effectively charging in the place subtracting time losses due to handling. The efficiency of the charging process has been set in 92% (more than that in WPT).

Considering how much energy can be charged in a daily charging event, the next calculation has been to estimate how many charging events per year can be expected from every EV user. The calculation distinguished between common users and professionals as this last probably charge more times, as their daily autonomy needs are higher.

For the scooter (or quadricycles, or e-bikes), a fleet of 10 scooters were considered for the two 3.6 kW low power chargers.

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Driver habits				Charging events /Week and EV		Event/year	% use of ultra fast charger	Times charging in opportunity Charger
	2025							Per year/1 EV
Weekly sup/charge events by home cars	0.03	EVs	per week	1.5	**Home use**	78.21	2.00%	**1.56**
Weekly sup/events for proffessionals	0.08	EVs	per week	2.5	**Duty user**	130.35	3.00%	**3.91**
							% Slow charger	1 Scooter
Weekly sup/events for Scooters	2.40	Scooters	per week	3.0	**Share Sco**	156.4	80.00%	125.1
Weeks per year	**52.14**				**Nº of scooters**		10	10 Sccoters
Days per year	**365**				**Charging point Scoote**		4 CPs	**1,251**

Table 31. UC4 Expected charging events per year and EV / e-Scooter

Then, the energy needs were calculated for the ultrafast charger but also the e-Scooters chargers

6.1.3 Key business roles

In this UC4, multiple stakeholders play an active role, and many combinations and business models could be designed.

From the visual analysis of the e3value network diagram (D9.1), it is evident that the Charging Point Operator (CPO), as it receives 7 inputs and generates 3 outputs, is the most connected role in the ecosystem.

Some of the inputs received by the CPO are common to this role in other UCs: charging stations from the manufacturers, electricity from the utilities and connectivity from a telecom operator. However, there are at least 3 key differences in other inputs: 1) power could be provided by the utility, but in this case, it could be also (or exclusively) delivered by the public mobility company through the tramway DC grid; 2) land and parking space owners are key for the CPO in this case, as the park & ride facility requires a considerable amount of space; 3) public authorities would foster this business model because of the synergies it has with public infrastructure and mobility services. For this purpose, tenders would be launched specifying the requirements of such park and ride facility.

6.2 Revenue model

In the charging hub, placed at the park-and-ride facility, multiple charging technologies could cohabit. On the one hand, a time-based revenue model could be the most adequate for low-power chargers, as they may be simultaneously used as parking spot for several hours. These vehicles could even be used to balance the whole fleet of EVs in the hub using V2G capabilities or contributing to provide grid services. On the other hand, an energy-based revenue model would be interesting for fast DC chargers.

For simplification, this model will only consider energy-based revenue, which is proportional to the electricity cost.

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6.3 Pricing strategy

The pricing strategy in this UC4 is based on the cost of electricity (fixed power concept and variable energy concept) for the asset owner who also acts as charging point operator in the model.

The electricity cost is computed together with other cost components such as asset amortization, personnel, etc. and shared among the expected occupancy. Overall, a benefit margin would be applied.

Although the current approach is reasonable, a more detailed pricing fixation analysis would be convenient in the future, quantifying the willingness to pay for the service provided, and using dynamic pricing strategies that consider, for example, the convenience of incentivising consumption of energy when there is excess or cheap electricity, and penalising the consumption when there are peaks or grid congestion.

Managing the Ride and Park facilities with the technologies learned in UC1 (Smart Charging and V2G) could be extremely useful in this case, as EVs will be, in general, left on site for a full day allowing for distributed charging and to use them as temporary energy storage systems. Therefore, pricing strategy should be analysed in future projects in detail as there are main options to make the model concept very attractive.

6.4 Financial model UC4

The complete revenues' projection can be found in the Excel attached for UC4. These projections have been calculated for years 2025, 2030 and 2035, although 2030 is the year selected for the sensitivity analysis. The projection is made for 15 years by default which is the period set for the depreciation of the asset although it could be extended. The revenues are subject to be inflation (0% by default) and have been calculated out of VAT. In the initial assumptions, the number of charging events that happens in the Fast and Ride facility from the total a family or a professional make in a year, have been set in 2% and 4% respectively. This is aligned with the percentages indicated in several articles of the use of the public chargers, as users prefer to charge at home or in the offices. Then, depending on the complete fleet of EVs in the city there will be a limitation of charging event by capacity of the Ride and Park but also by the existing vehicles. The market fix the number until the full capacity is reached.

6.4.1 Revenue projections UC4

The complete revenues' projection can be found in the Excel attached for UC4. The projection is made for 15 years by default which is the period set for the depreciation of the asset although it could be extended or reduced. The revenues are subject to be inflated (0% by default) and have been calculated out of VAT.

In the initial assumptions, the selling prices, the electricity costs and other variable costs decrease 1% per year whilst OPEX and other fix costs decreases by 2% annually. This assumption can be modified but it is expected a cost and prices reduction due to the higher penetration of the Renewables. Costs will drop more than prices because the economies of scale effect will be produced, and the learning curve will also allow it. However, prices will not reflect completely this trend trying to improve the profitability and recover some investments that were very compromised at the early stages.

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UC4. REVENUES	2030	1	2	3	4	5
Flag 2030		1	1	1	1	1
Year		2030	2031	2032	2033	2034
Total Revenues Charger	**k€**	**159,311**	**157,718**	**156,140**	**154,579**	**153,033**
Sales of electricity without VAT	**k€**	**159,311**	**157,718**	**156,140**	**154,579**	**153,033**
Fare (without VAT)	€/MWh	421.3	417.1	413.0	408.8	404.7
Volume	MWh	353	353	353	353	353
Fare (without VAT) Slow charging	€/MWh	296.4	293.4	290.5	287.6	284.7
Volume	MWh	36	36	36	36	36
Grants		**0**	**0**	**0**	**0**	**0**
Lifetime Equipment	15					

Table 32. UC4. Revenue model 2030. Partial data (5 years)

6.4.2 OPEX projections UC5

The OPEX table includes the total costs of goods sold (COGS) and General Expenses (SG&A). The COGS adds fix costs (operation and maintenance, other fix costs like the power component of the tariff and disposal costs) and variable costs (electricity costs, which depends on costs of electricity and volume, and other compensation costs). Electricity costs are reduced a 2% yearly due to the penetration of Renewables, although this variable can be modified. All the figures are out of VAT and are set with an inflation rate of 0% although this assumption can be also modified in the "Assumption tab". The OPEX table also shows the depreciation of the assets (including the upfront costs to manufacture the infrastructure (year 2029), the depreciation of the equipment for billing and communication (year 2030) and the renewal costs after 7 years with a value equivalent to 35 % of the initial upfront costs.

OPEX	2030		1	2	3	4	5
Flag 2030			1	1	1	1	1
Year		2,029	2,030	2,031	2,032	2,033	2,034
Total Costs of Goods sold	**€**		**(40,471)**	**(39,893)**	**(39,324)**	**(38,765)**	**(38,214)**
Fix Costs	**€**		**(3,543)**	**(3,472)**	**(3,403)**	**(3,334)**	**(3,268)**
Transport and distribution, charges (Power)	€		**(3,543)**	**(3,472)**	**(3,403)**	**(3,334)**	**(3,268)**

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Variable Costs	**€**		**(24,473)**	**(24,215)**	**(23,960)**	**(23,707)**	**(23,458)**
Transport and distribution (electricity)	**€**	-	**(7,414)**	**(7,335)**	**(7,258)**	**(7,182)**	**(7,106)**
Cost per unit 150 kW	€/MWh		(19.88)	(19.68)	(19.48)	(19.29)	(19.09)
Cost per unit slow 3.6 kW	€/MWh		(11.17)	(10.94)	(10.72)	(10.51)	(10.30)
Volume 150 kW	MWh /y		353	353	353	353	353
Volume slow 3.6 kW	MWh /y		36	36	36	36	36
Electricity costs	**E**		**(17,060)**	**(16,880)**	**(16,702)**	**(16,526)**	**(16,352)**
Cost per unit 150 kW	€/MWh		(45.74)	(45.28)	(44.83)	(44.38)	(43.94)
Cost per unit slow 3.6 kW	€/MWh		(25.70)	(25.18)	(24.68)	(24.18)	(23.70)
Volume ultrafast 150 kW	MWh /y		353	353	353	353	353
Volume slow 3.6 kW	MWh /y		36	36	36	36	36
Other fix costs /incomes			**(12,455)**	**(12,206)**	**(11,962)**	**(11,723)**	**(11,488)**
O&M	**€**	-	**(12,455)**	**(12,206)**	**(11,962)**	**(11,723)**	**(11,488)**
Operation 150 kW	€		(7,422)	(7,274)	(7,128)	(6,986)	(6,846)
Maintenance 150 kW	€	-	(5,033)	(4,932)	(4,834)	(4,737)	(4,642)
Operation slow chargers 3.6 kW	€		(1,856)	(1,818)	(1,782)	(1,746)	(1,712)
Maintenance slow chargers 3.6 kW	€		(1,258)	(1,233)	(1,208)	(1,184)	(1,161)
Disposal costs			-	-	-	-	-
Disposal costs			-	-	-	-	-
SG&A and other costs	**€**	**7.0%**	**(649)**	**(636)**	**(624)**	**(611)**	**(599)**
Depreciation	**k€**		**(19,684)**	**(19,684)**	**(19,684)**	**(19,684)**	**(19,684)**
Lifetime	15						

Table 33. UC4. UC2. OPEX Costs 2035, lifetime 15 years, partial costs of first 5 years

6.4.3 Profit and losses UC4

This tab includes the profit and losses account (2030), till the “net incomes” line. No third parties financing is included, also the “free cash flow”, with the calculation of the NPV and the IRR, for a WACC of 6.5% equal for all the pilots to allow an easy comparison and finally there is a “taxes” table. The depreciation of the assets calculated in D9.4 and the occupancy are the main factors affecting the profitability of the model.

PROFIT AND LOSS ACCOUNT	2030						
			1	2	3	4	5
			1	1	1	1	1
YEAR		**Total**	**2030**	**2031**	**2032**	**2033**	**2034**
Revenues Sales of electricity	€		159,311	157,718	156,140	154,579	153,033
Public grant	€		-	-	-	-	-
Total Revenues	€	2,229,421	159,311	157,718	156,140	154,579	153,033
COGS	€		(40,471)	(39,893)	(39,324)	(38,765)	(38,214)
SG&A and other costs	€		(649)	(636)	(624)	(611)	(599)
Total Expenses	€	(546,803)	(41,121)	(40,530)	(39,948)	(39,376)	(38,813)
EBITDA	**€**	**1,682,617**	**118,190**	**117,188**	**116,192**	**115,203**	**114,220**
Depreciation and amortisation	€		(19,684)	(19,684)	(19,684)	(19,684)	(19,684)
	€						
EBIT	**€**	**1,362,574**	**98,506**	**97,504**	**96,508**	**95,519**	**94,536**
P&L interest expenses	€						
Taxes	€		(23,641)	(23,401)	(23,162)	(22,925)	(22,689)
Other	€						
Net Income / Loss	**€**	**1,035,557**	**74,864**	**74,103**	**73,346**	**72,594**	**71,847**

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Free Cash Flow							
Net incomes	**€**	**1,035,557**	**74,864**	**74,103**	**73,346**	**72,594**	**71,847**
Depreciation and amortisation	€		19,684	19,684	19,684	19,684	19,684
CAPEX							
FREE CAS FLOW UNLEVELIZED	**€**	**(308,589)**	**94,549**	**93,787**	**93,031**	**92,279**	**91,532**

NPV	**546,407 €**
IRR	**23.18%**
WACC	**6.5%**
Lifetime	**15**

Table 34. P&L year 2030 (lifetime 15 years, partial data for first 5 years)

6.4.4 Final Results UC4

The summary of results is shown in the next table for infrastructure set up in years 2025, 2030 or 2035. Initial results reflect that in all cases the IRR is far slightly over the WACC, indicating that this model if optimised could be profitable.

UC4. Hub. One DC/AC 150 kW bidirectional charge, and two DC/AC 3.6 kW bidirectional

		2,025	**2,030**	**2,035**
P&L				
TOTAL Sales	€	167,521	159,311	151,503
TOTAL Expenses	€	(44,225)	(41,121)	(38,259)
EBITDA	€	123,296	118,190	113,244
NET INCOMES	€	77,166	74,864	72,572
KPIs				
NPV	€	554,375	546,407	537,588
IRR	%	**27.61%**	**23.18%**	**24.46%**
WACC	%	6.5%	6.5%	6.5%
Lifetime		15	15	15
Inflation FLAG	0			

Table 35. UC2. Results for years 2025, 2030 and 2035

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6.4.5 Sensitivity

The sensitivity analysis allows to compare multi-variables or a couple of variables together and see how the NPV or the IRR evolve. This study may reflect how sensible is the model to the different factors. The calculation possibilities are enormous, so a combination of factors has been estimated that, in our opinion, are the most decisive in making the project profitable.

6.4.5.1 Multivariable Analysis

Select Scenario In Scenarios 2 to 4, play with the percentages, not numbers, in 5 to 7 modify numbers

Table 1. UC4. Sensitivity 2030. Multivariables	1		1		2		3		4	5	6	7
		UNITS	SCE base		SCE 2		SCE 3		SCE 4	SCE 5	SCE 6	SCE 7
COSTS												
CAPEX	Don`t touch		Don`t touch									
CAPEX Infrastructure	252,329	€	252,329	-10%	227,096	10%	277,562	**-10%**	227,096	252,329	252,329	252,329
CAPEX Renewal	24,778	€	24,778	-10%	22,300	10%	27,255	**-10%**	22,300	24,778	24,778	24,778
Lifetime of Equipment	15	Years	15		15		15		15	**15**	**15**	**15**
OPEX												
Operation Costs year 1, 150 kW	7,422	€/year 1	7,422	-10%	6,680	10%	8,165	**-10%**	6,680	7,422	7,422	7,422
Maintenance costs year 1, 150 kW	5,033	€/year 1	5,033	-10%	4,530	10%	5,536	**-10%**	4,530	5,033	5,033	5,033
Operation Costs year 1, 3.6 kW	1,856	€/year 2	1,856	-10%	1,670	10%	2,041	**-10%**	1,670	1,856	1,856	1,856
Maintenance costs year 1, 3.6 kW	1,258	€/year 3	1,258	-10%	1,132	10%	1,384	**-10%**	1,132	1,258	1,258	1,258
Cost of electricity 150 kW	55.8	€/MWh	55.8	-10%	50	10%	61.4	**-10%**	50.2	55.8	55.8	55.8
Other variable costs 150 kW	24.3	€/MWh	24.3	-10%	22	10%	26.7	**-10%**	21.8	24.3	24.3	24.3
Cost of electricity 2*3.6 kW	31.35	€/MWh	31.3	-10%	28.21	10%	34.5	**-10%**	28.2	31.3	31.3	31.3
Other variable costs 2*3.6 kW	13.62	€/MWh	13.6	-10%	12.26	10%	15.0	**-10%**	12.3	13.6	13.6	13.6
ECONOMIC INDEXES												
WACC	6.5%	%	6.5%	0%	6.5%	0%	6.5%	**0%**	6.5%	6.5%	6.5%	6.5%
Inflation prices	0.0%	%	0.0%	0%	0.0%	0%	0.0%	**0%**	0.0%	0.0%	1.5%	2.0%
Inflation costs	0.0%	%	0.0%	0%	0.0%	0%	0.0%	**0%**	0.0%	0.0%	2.0%	1.5%
% SG&A and other costs /labour OPEX	7.0%	%	7.0%	0%	7.0%	0%	7.0%	**0%**	7.0%	7.0%	7.0%	7.0%
OTHER FACTORS												
LOCATION												
Efficiency of location 150 kW Charger	70.0%	%	70.0%	-10%	63.0%	10%	77.0%	10%	77.0%	70.0%	70.0%	70.0%
Efficiency Charging process 150 KW	92.0%	%	92.0%	-10%	82.8%	10%	101.2%	10%	101.2%	92.0%	92.0%	92.0%
Efficiency of location 3.6 Chargers	75.0%	%	75.0%	-10%	67.5%	10%	82.5%	10%	82.5%	75.0%	75.0%	75.0%
Efficiency Charging process 3.6 kW Ch	92.0%	%	92.0%	-10%	82.8%	10%	101.2%	10%	101.2%	92.0%	92.0%	92.0%
% Charge events by home cars in Opp	2.0%	%	2.0%	-10%	1.8%	10%	2.2%	10%	2.2%	2.0%	2.0%	2.0%
% Charge events for proffessionals in	3.0%	%	3.0%	-10%	2.7%	10%	3.3%	10%	3.3%	3.0%	3.0%	3.0%
% Charge events for proffessionals in	80.0%	%	80.0%	-10%	72.0%	10%	88.0%	10%	88.0%	80.0%	80.0%	80.0%
PRICES												
Conductive Electricity Tariff price 150	514.04	€/Mwh year 1	514.04	-10%	462.64	10%	565.45	**10%**	565.45	514.04	565.45	565.45
Conductive Electricity Tariff price 3.6	361.6	€/Mwh year 1	361.56	-10%	325.41	10%	397.72	**10%**	397.72	361.56	397.72	397.72
Grant over sales of electricity	0.0%	%	0.0%	0%	0.0%	0%	0.0%	**0%**	0.0%	5.0%	0.0%	**5.0%**
RESULTS												
NPV	546,407	€	546,407		330,882		816,527		918,480	600,131	666,171	733,713
IRR (post tax)	**23.18%**	%	23.18%		**18.10%**		**28.30%**		34.13%	**24.56%**	**26.22%**	**27.88%**

Table 36. UC4. Multivariable Analysis

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Scenario 1. The conditions are those of the base case in year 2030. IRR reflects 23.18 % above the WACC (6.5%)

Scenario 2. CAPEX and OPEX are decreased 10% and efficiency of location, efficiency of process and % of charge events are also decreased a 10%. The result is worst with an IRR of 18.10 %

Scenario 3. CAPEX and OPEX are increased 10% and efficiency of location, efficiency of process and % of charge events are also increased a 10%. The result is better with an IRR of 28.30 %.

Scenario 4. CAPEX and OPEX are decreased 10% but efficiency of location, efficiency of process and % of charge events are increased a 10%. The result is clearly above the WACC with an IRR of 34.13% (the highest of all the UCs)

Scenario 5. Same conditions than scenario 1, but a 5% of grant over the electricity revenues, deriving in a 24.56 % IRR.

Scenario 6. Same conditions than scenario 1 but increasing prices of electricity by a 10%. IRR 26.22%

Scenario 7. Same conditions than scenario 1 but increasing prices of electricity by 10% and providing a grant of 5% over the electricity revenues. IRR over the WACC 27.88 %.

6.4.5.2 Dual Variable Analysis

For the dual variable analysis, two factors are selected and modified a 10% and 15% up and down. Then, the sensitivity is applied, and the IRR is modified for each couple of values. A color code reflects the results; the greener the most profitable, the red the less.

The following comparisons have been implemented:

Analysis 1. CAPEX versus conductive prices. Wireless prices are those for conductive equivalent power values, multiplied by a factor that it is 1 by default. Usually, wireless prices per MWh should be slightly over those for conductive.

SCEN	**1**			**CAPEX**		
IRR	**23.18%**	290,178 €	277,562 €	**252,329 €**	227,096 €	214,480 €
	591.1	24.37%	25.19%	26.98%	29.02%	30.15%
	565.4	23.22%	24.01%	25.74%	27.71%	28.81%
Conductive	**514.0**	20.83%	21.56%	23.18%	25.01%	26.03%
Prices 150 kW	462.6	18.31%	18.99%	20.48%	22.18%	23.12%
	436.9	17.00%	17.65%	19.08%	20.70%	21.60%

Table 37. UC4 Dual Analysis. CAPEX versus Prices

Electricity prices can modify greatly the results. A 15% up in prices provides an 26.98% IRR with the same CAPEX

Analysis 2. CAPEX versus Grant over revenues

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SCEN	1			CAPEX		
IRR	23.18%	290,178 €	277,562 €	**252,329 €**	227,096 €	214,480 €
	6.60%	22.53%	23.30%	25.00%	26.94%	28.01%
	5.50%	22.25%	23.02%	24.70%	26.62%	27.68%
Grant over sales	**5.00%**	22.12%	22.89%	24.56%	26.48%	27.54%
	4.50%	21.99%	22.76%	24.43%	26.33%	27.39%
	4.00%	21.87%	22.63%	24.29%	26.19%	27.24%

Table 38. UC4 CAPEX versus Grant

The impact of the Grants is not so acute with an slight increase of WACC over the situation of no grant (from 23.18 % with no Grant) to 24.56 with 5% Grant.

Analysis 3. CAPEX versus operation costs

SCEN	1			CAPEX		
IRR	23.18%	290,178 €	277,562 €	252,329 €	227,096 €	214,480 €
	9,389.2	20.49%	21.22%	22.82%	24.63%	25.64%
	8,164.5	20.70%	21.43%	23.04%	24.87%	25.89%
Operation Cost	7,422.3	20.83%	21.56%	23.18%	25.01%	26.03%
	6,680.0	20.95%	21.69%	23.31%	25.16%	26.18%
	6,308.9	21.02%	21.76%	23.38%	25.23%	26.25%

Table 39. UC4. CAPEX versus Operation Costs

In this case, the comparison was done with the operation costs instead of the maintenance costs, as those costs will be higher due the complexity of the Park and Ride facility. It can be seen that the increase of 15% up or down do not affect too much the IRR

Analysis 4. Tariff of 150 kW versus tariff of 3.6 kW chargers

SCEN	1			Tarif 150 kW		
IRR	**23.18%**	591.1	565.4	**514.0**	462.6	436.9
	415.8	27.24%	26.01%	23.46%	20.78%	19.39%
	397.7	27.16%	25.92%	23.36%	20.68%	19.28%
Tarif 3.6 kW	**361.6**	26.98%	25.74%	23.18%	20.48%	19.08%
	325.4	26.80%	25.56%	22.99%	20.28%	18.87%
	307.3	26.71%	25.47%	22.89%	20.18%	18.77%

Table 40. UC4. Comparative of tariffs for 150 kW and 3.6 kW chargers

The increase or decrease of the 150 kW tariff, introduce much variation in the IRR than the smaller one. The first one moves from 27.24 % in the best case to 19.39 % in the worst (almost 8 points of variation). The second one moves from 26.71 % in the best case to 27.24 %, just less than 1% of variation.

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7 USE CASE 5. SUPERFAST CHARGING SYSTEMS FOR EUROPEAN CORRIDORS

7.1 Description

7.1.1 UC description

The main objective is to develop an innovative Super-Fast Charging (SFC) system with two 1175/200 kW DC super-fast chargers that provide ancillary services and EV charging service for EV users at Tallinn peri-urban area gas stations. The partners involved in UC5 are Eesti Energia and CIRCE.

This technology contributes to reduce the range anxiety, that is one of the major concerns of users on long-range trips. In this sense, taking for example a 40 kWh battery, it will only take 10 minutes to fully charge the EV using this super-fast charger. Both superfast chargers were commissioned at mid-June 2024, one in Peterburi tee 58 a and the second at Uus-Ringi tee 3.

Moreover, these SFCs, that are generally seen as a burden for electricity distribution grids since they consume high amounts of energy in short timeframes requiring expensive investments in strengthening the grid to cover the peak load of their systems, could serve a dual purpose. In this sense, they will act as an active power filter that supports the stability of the grid during time periods when it is idle from charging electric vehicles. Therefore, the investment cost for setting up the SFCs system will become smaller since the DSO would no longer need to invest into installing active power filters. However, their profitability is doubtful when they are installed in the main highways due to the low occupancy.

7.1.2 Business case

The high-power DC chargers provide charging services to EV-drivers through Enefit VOLT platform, but also grid services that are of great interest to DSOs and TSOs. These services are controlled by an specified software so power electronics can assist the grid according to DSO requirements when no electric vehicles are connected to the charger:

1. Grid services when unpredictable and rapid high loads at the end of long feeders causing voltage drops that affect all connected devices/customers. In such cases, the Super-Fast chargers act either as a remotely controlled load, or as static reactive compensator with high response time to avoid voltage drops.
2. Grid services when high volumes of low voltage distributed energy resources affect the power quality. By installing bidirectional charger to the grid, it can respond to the generation by controlling the production/consumption.

Although there are 2 SPCs pilots in the project, for the business models we have considered just one isolated unit, in a highway station. However, it was considered the number of EVs (conventional users and professionals) per SFC station. In the case of Tallinn, there is a very ambitious deployment strategy of high-power units according to the estimations done in D9.2.

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If this is the case, the potential charging events will diminish overtime as there are more points to charge along the city and in the periphery. As it was mentioned in this report previously, it is really important to match the deployment of EVs with the deployment of Chargers or in case of excess of Chargers, they will not be profitable. This seems to be the case for Tallinn and explains why the business model starts to improve from 2025 to 2030 but suddenly modify the trend and bring losses in 2035.

However, it is important to highlight, that the occupancy will be much lower than for instance in the UC4 (Park and ride), especially if the number of EVs per SFCs start to drop abruptly in the city and surroundings (as seems to be the case). There are not available figures of the real occupancy in the highways. We have considered that a conventional home user charge solely a 0.80 % of the times in a SFCs (because of the high price) and the professionals double (1.60%). In this case, the assumptions are the following:

Lifetime of equipment	15	years
Amortization	Lineal	
Average charging time	20	minutes
Charging capacity	200	kW
Maximum charging events per day	25	events
Efficiency of location	75%	%
Achievable charging events per day	19	events/day
Achievable charging events per year	6,844	events/year
Efficiency Charging process	92%	%
Total kWh storaged in one charging event	61	kWh
Total kWh for 100 km	18	kWh
Total autonomy with one charge event	341	km

Table 41. UC5. SFC at Tallinn. Main assumptions

The efficiency of locations represents the time that the EV are effectively charging in the place subtracting time losses due to car substitution and other losses. The efficiency of the charging process has been set in 92%.

The assumptions for the charging habits are indicated below

Driver habits	2025		Event/week	Event/year	% Supcharger	Per year/EV
Weekly sup/charge events by home cars	0.01	per week	1.5	78.21	0.80%	0.63
Weekly sup/events for proffessionals	0.04	per week	2.5	130.35	1.60%	2.09
Weeks per year	52.14	weeks				
Days per year	365	days				

Table 42. UC5. Charging habits

7.1.3 Key business roles

The value network analysis of UC5 (see D9.1) shows that private initiative could be enough to promote superfast charging infrastructure. Public authorities could have a secondary role.

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Starting from the knowledge created by universities and research centres, a high-power DC charger would be developed by a technology provider, manufactured by a specialized company, and finally installed and operated by a Charging Point Operator (CPO).

To pay for the land and the infrastructure, the CPO would get income streams from the DSO in exchange for grid services (compensation of voltage drops and reactive power) and from the electro-mobility providers that would collect the payments from the end users of the charging sessions service.

7.2 Revenue model

In fast charging infrastructures, where charging stops are short and rotation needs to be as high as possible, energy-based is usually the most interesting revenue model.

A second revenue stream that is enabled by the power electronics in these types of chargers is the provision of grid regulation services. Nevertheless, the financial models herein only consider the EV driver as the end customer for simplification.

The Revenue Model should also consider that when you stop at a traditional filling station equipped with fast or ultrafast charging, you will probably attract more vehicles (electric and plug in) than proportionally from all vehicles circulating through the highway. The owners of these vehicles will likely use the services of the filling station (food, shops) during more time than a conventional ICE driver, waiting for the complete EV charge.

7.3 Pricing strategy

The pricing strategy in this UC is based on the cost of electricity (fixed power concept and variable energy concept) for the asset owner who also acts as charging point operator in the model.

The electricity cost is computed together with other cost components such as asset amortization, personnel, etc. and shared among the expected occupancy. Overall, a benefit margin would be applied.

Although the current approach is reasonable, a more detailed pricing fixation analysis would be convenient in the future, quantifying the willingness to pay for the service provided, and using dynamic pricing strategies.

At these places, prices can be higher than at the city center, because the users of highways will not have many options to charge during the trip and will necessarily accept those prices.

7.4 Financial model UC5

The complete revenues' projection can be found in the Excel attached for UC5. These projections have been calculated for years 2025, 2030 and 2035, although 2030 is the year selected for the sensitivity analysis. The projection is made for 15 years by default which is the period set for the depreciation of the asset although it could be extended or reduced. The revenues are subject to the inflation index (0% by default) and have been calculated out of VAT. In the initial assumptions, the number of charging events that happens in the SFCs at a highway from the total a home/office or professional drivers make in a year, have been set in 0.8% and 1.6% respectively. Despite there are some references in technical articles, we couldn't find a consensus in these figures and for sure they will vary from one facility to another, so we set those as a reference that could be modified once real data will be available.

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7.4.1 Revenue projections UC5

In the initial assumptions, the selling prices, the electricity costs and other variable costs decrease 1% per year whilst OPEX and other fix costs decreases by 2% annually. This assumption can be modified but it is expected a cost and prices reduction due to the higher penetration of the Renewables. Costs will drop more than prices because the economies of scale effect will be produced, and the learning curve will also allow it. However, prices will not reflect completely this trend trying to improve the profitability and recover some investments that for sure, were very compromised at the early stages when very few users charge at those places.

REVENUES	2030		1	2	3	4	5
Flag 2030			1	1	1	1	1
Year		**Total**	**2030**	**2031**	**2032**	**2033**	**2034**
Total Revenues Charger	**k€**	**959,986**	**84,671**	**81,700**	**78,817**	**75,999**	**73,230**
Sales of electricity without VAT	**k€**	**959,986**	**84,671**	**81,700**	**78,817**	**75,999**	**73,230**
Fare (without VAT)	€/MWh		421.3	417.1	413.0	408.8	404.7
Volume	MWh		201	196	191	186	181
Grants		**0**	**0**	**0**	**0**	**0**	**0**
Lifetime Equipment	15						

Table 43. UC5. Revenues year 2030. Partial data from first 5 years

7.4.2 OPEX projections UC5

The OPEX table includes the total costs of goods sold (COGS) and General Expenses (SG&A). The COGS adds fix costs (operation and maintenance, other fix costs like the power component of the tariff and disposal costs) and variable costs (electricity costs, which depends on costs of electricity and volume, and other compensation costs). Electricity costs are reduced a 2% yearly due to the penetration of Renewables, although this variable can be modified. All the figures are out of VAT and are set with an inflation rate of 0% although this assumption can be also modified in the "Assumption tab". The OPEX table also shows the depreciation of the assets (including the upfront costs to manufacture the infrastructure (year 2029), the depreciation of the equipment for billing and communication (year 2030) and the renewal costs after 7 years with a value equivalent to 35 % of the initial upfront costs.

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OPEX	2030							
				1	2	3	4	5
Flag 2030				1	1	1	1	1
Year			2,024	2,030	2,031	2,032	2,033	2,034
Total Costs of Goods sold	€	**(371,300)**		**(29,284)**	**(28,499)**	**(27,735)**	**(26,987)**	**(26,252)**
Fix Costs	€	**(61,747)**		**(4,724)**	**(4,629)**	**(4,537)**	**(4,446)**	**(4,357)**
Transport and distribution, charges (Power)	€			**(4,724)**	**(4,629)**	**(4,537)**	**(4,446)**	**(4,357)**
Other fix costs /incomes		**(160,052)**		**(11,374)**	**(11,147)**	**(10,924)**	**(10,705)**	**(10,491)**
O&M	€	**(148,676)**	-	**(11,374)**	**(11,147)**	**(10,924)**	**(10,705)**	**(10,491)**
Operation				(7,324)	(7,178)	(7,034)	(6,894)	(6,756)
Maintenance			-	(4,050)	(3,969)	(3,889)	(3,811)	(3,735)
Disposal costs		**(11,376)**		-	-	-	-	-
Variable Costs	€	**(149,502)**		**(13,186)**	**(12,723)**	**(12,274)**	**(11,836)**	**(11,404)**
Transport and distribution (electricity)	€	**(45,288)**	-	**(3,994)**	**(3,854)**	**(3,718)**	**(3,585)**	**(3,455)**
Cost per unit	€/MWh			(19.88)	(19.68)	(19.48)	(19.29)	(19.09)
Volume	MWh			201	196	191	186	181
Electricity costs	E	**(104,214)**		**(9,192)**	**(8,869)**	**(8,556)**	**(8,250)**	**(7,950)**
Cost per unit	€/MWh	#REF!		(45.74)	(45.28)	(44.83)	(44.38)	(43.94)
Volume	MWh			201	196	191	186	181
SG&A and other costs	€	(6,702)	**7.0%**	**(513)**	**(502)**	**(492)**	**(483)**	**(473)**
Depreciation	k€	**(197,682)**		**(12,318)**	**(12,318)**	**(12,318)**	**(12,318)**	**(12,318)**
Lifetime	15							

Table 44. UC5. OPEX Costs (partial data from first 5 years)

7.4.3 Profit and losses. UC5.

This tab includes the profit and losses account (2030), till the "net incomes" line. No third parties financing is included, also the "free cash flow", with the calculation of the NPV and the IRR, for a WACC of 6.5% equal for all the pilots to allow an easy comparison and finally there is a "taxes" table.

The depreciation of the assets calculated in D9.4 and the occupancy are the main factors affecting the profitability of the model. In the Excel sheet, the calculation of the taxes is also included.

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PROFIT AND LOSS ACCOUNT 2030

				1	2	3	4	5
				1	1	1	1	1
YEAR		Total	2029	2030	2031	2032	2033	2034
Revenues Sales of electricity	€			84,671	81,700	78,817	75,999	73,230
Public grant	€			-	-	-	-	-
Total Revenues	€	959,986	-	84,671	81,700	78,817	75,999	73,230
COGS	€			(29,284)	(28,499)	(27,735)	(26,987)	(26,252)
SG&A and other costs	€			(513)	(502)	(492)	(483)	(473)
	€							
	€							
Total Expenses	€	(378,002)	-	(29,797)	(29,002)	(28,227)	(27,469)	(26,725)
EBITDA	**€**	**581,984**	**-**	**54,875**	**52,699**	**50,590**	**48,530**	**46,505**
Depreciation and amortisation	€			(12,318)	(12,318)	(12,318)	(12,318)	(12,318)
	€							
EBIT	**€**	**384,301**	**-**	**42,557**	**40,381**	**38,272**	**36,212**	**34,187**
P&L interest expenses	€							
Taxes	€			(10,639)	(10,095)	(9,568)	(9,053)	(8,547)
Other	€							
Net Income / Loss	**€**	**288,226**	**-**	**31,918**	**30,286**	**28,704**	**27,159**	**25,640**
				37.70%	37.07%	36.42%	35.74%	35.01%
Free Cash Flow								
Net incomes	**€**	**232,539**	**-**	**31,918**	**30,286**	**28,704**	**27,159**	**25,640**
Depreciation and amortisation	€			12,318	12,318	12,318	12,318	12,318
CAPEX								
FREE CAS FLOW UNLEVELIZED	**€**		**(190,458)**	**44,235**	**42,603**	**41,022**	**39,477**	**37,958**

NPV	**131,927 €**
IIR	**17.74%**
WACC	**6.5%**
Lifetime	15

Table 45. UC5. P&L Account. Partial data of first 5 years

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7.4.4 Final Results. UC5.

The summary of results is shown in the next table for infrastructure set up in years 2025, 2030 or 2035. Initial results reflect that in all cases the IRR is over the WACC, indicating that this model can be profitable. The profitability is highest in 2030 is due to the additional EVs deployment (according to the study done in D9.2).

TALLIN (200 KW Ultrafast charger)			2,025		2,030		2,035
P&L							
TOTAL Sales	€		80,895		84,671		70,496
TOTAL Expenses	€		(32,535)		(29,797)		(25,993)
EBITDA	€		48,360		54,875		44,503
NET INCOMES	€		21,430		31,918		25,464
KPIs							
NPV	€	€	55,427	€	131,927	€	76,935
IRR	%		9.32%		17.74%		14.80%
WACC	%		6.5%		6.5%		6.5%
Lifetime			15		15		15
Inflation FLAG	NO						

Table 46. UC5. Final Results

7.4.5 Sensitivity

The sensitivity analysis allows to compare multi-variables or a couple of variables together and see how the NPV or the IRR evolve. This study may reflect how sensible is the model to the different factors. The calculation possibilities are enormous, so a combination of factors has been estimated that, in our opinion, are the most decisive in making the project profitable, but the readers may propose new combinations at their convenience using the Excel Spreadsheet.

7.4.5.1 Multivariable analysis

The explanation on how the multivariable and dual variable analysis works can be found in the Excel sheet linked to the report (UC5 Tallinn).

The table is fed by some data (CAPEX, OPEX and other Economic Indexes (like inflation, WACC or percentage for SG&A) and also some other factors like the efficiency of location, the efficiency of the charging process, the % of charging events by home users and or professionals and the prices and grants. Then, the table provide at the end the Net Present Value (NPV) and the Internal Rate of Return (IRR) or profitability of the business. The scenarios aside allow the modification of these variables obtaining new values for the NPV and the IRR

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Select Scenario — In Scenarios 2 to 4, play with the percentages, not numbers, in 5 to 7 modify numbers

UC5. 1 SFC of 200 kW . Tallinn Table 1. Sensitivity 2030.	1	UNITS	1 SCE base		2 SCE 2		3 SCE 3		4 SCE 4	5 SCE 5	6 SCE 6	7 SCE 7
COSTS												
CAPEX	Don`t touch		Don`t touch									
CAPEX Infrastructure	141,833	€	141,833	**-10%**	127,650	**10%**	156,016	**-10%**	127,650	141,833	141,833	141,833
CAPEX Renewal	12,913	€	12,913	**-10%**	11,622	**10%**	14,204	**-10%**	11,622	12,913	12,913	12,913
Lifetime of Equipment	15	Years	15		15		15		15	**15**	**15**	**15**
OPEX												
Operation Costs year 1	7,324	€/year 1	7,324	**-10%**	6,592	**10%**	8,057	**-10%**	6,592	7,324	7,324	7,324
Maintenance costs year 1	4,050	€/year 1	4,050	**-10%**	3,645	**10%**	4,455	**-10%**	3,645	4,050	4,050	4,050
Cost of electricity	55.8	€/MWh	55.8	**-10%**	50	**10%**	61.4	**-10%**	50.2	55.8	55.8	55.8
Other variable costs	24.3	€/MWh	24.3	**-10%**	22	**10%**	26.7	**-10%**	21.8	24.3	24.3	24.3
ECONOMIC INDEXES												
WACC	6.5%	%	6.5%	**0%**	6.5%	**0%**	6.5%	**0%**	6.5%	6.5%	6.5%	6.5%
Inflation prices	0.0%	%	0.0%	**0%**	0.0%	**0%**	0.0%	**0%**	0.0%	0.0%	1.5%	2.0%
Inflation costs	0.0%	%	0.0%	**0%**	0.0%	**0%**	0.0%	**0%**	0.0%	0.0%	2.0%	1.5%
% SG&A and other costs /labour OPEX	7.0%	%	7.0%	**0%**	7.0%	**0%**	7.0%	**0%**	7.0%	7.0%	7.0%	7.0%
OTHER FACTORS												
LOCATION												
Efficiency of location 200 kW Charger	75.0%	%	75.0%	-10%	67.5%	10%	82.5%	10%	82.5%	75.0%	75.0%	75.0%
Efficiency Charging process 200 KW	92.0%	%	92.0%	-10%	82.8%	10%	101.2%	10%	101.2%	92.0%	92.0%	92.0%
% Charge events by home cars	0.75%	%	0.75%	-10%	0.7%	10%	0.8%	10%	0.8%	0.8%	0.8%	0.8%
% Charge events for proffessionals	1.00%	%	1.00%	-10%	0.9%	10%	1.1%	10%	1.1%	1.0%	1.0%	1.0%
PRICES												
Conductive Electricity Tariff price 200 kW	514.04	€/Mwh year 1	514.04	-10%	462.64	10%	565.45	**10%**	565.45	514.04	565.45	565.45
Grant over sales of electricity	0.0%	%	0.0%	0%	0.0%	0%	0.0%	**0%**	0.0%	5.0%	0.0%	**5.0%**
RESULTS												
NPV	131,927	€	131,927		43,171		244,782		302,900	155,714	183,780	213,979
IRR (post tax)	**17.74%**	%	17.74%		**10.73%**		**25.05%**		32.63%	**19.61%**	**21.79%**	**24.09%**

Table 47. UC5. Multivariable Analysis

Scenario 1. The conditions are those of the base case in year 2030. IRR reflects 17.74 % above the WACC (6.5%)

Scenario 2. CAPEX and OPEX are decreased 10% and efficiency of location, efficiency of charging process, % charging events by home users and professionals in Opportunity chargers are also decreased a 10%. The result is worst with an IRR of 10.73 %

Scenario 3. CAPEX and OPEX are increased 10% and efficiency of location, efficiency of charging process, % charging events by home users and professionals in Opportunity chargers are also increased a 10%. The result is better with an IRR of 25.05 % far over the WACC.

Scenario 4. CAPEX and OPEX are decreased 10% but efficiency of location, efficiency of charging process, % charging events by home users and professionals in Opportunity chargers are increased a 10%. The result is clearly above the WACC with an IRR of 32.67%

Scenario 5. Same conditions than scenario 1, but a 5% of grant over the electricity revenues, deriving in a 19.61 % IRR.

Scenario 6. Same conditions than scenario 1 but increasing prices of electricity by 10%. IRR 21.79%

Scenario 7. Same conditions than scenario 1 but increasing prices of electricity by a factor of 10 and providing a grant of 5% over the electricity revenues. IRR over the WACC 24.09 %.

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7.4.5.2 Dual variable analysis

For the dual variable analysis, two factors are selected and modified a 10% and 15% up and down. Then, the sensitivity is applied, and the IRR is modified for each couple of values. A colour code reflects the results; the greener the most profitable, the red the less.

The following comparisons have been implemented:

Analysis 1. CAPEX versus % Charging events of home users in Opportunity SFCs in highways

	SCEN	1			CAPEX		
	IRR	**17.74%**	163,108 €	156,016 €	**141,833 €**	127,650 €	120,558 €
		0.86%	18.46%	19.29%	21.13%	23.23%	24.41%
		0.83%	17.44%	18.24%	20.01%	22.04%	23.17%
% Events in SFC		**0.75%**	15.36%	16.10%	17.74%	19.62%	20.67%
Home users		0.68%	13.23%	13.91%	15.43%	17.16%	18.13%
		0.64%	12.14%	12.80%	14.25%	15.91%	16.83%

Table 48. UC5. CAPEX versus 5 Charging events by home users

This index is equivalent to occupancy and consequently the IRR is greatly affected by it. A 15% increase in charging events in highways by home users moves the IRR from 17.74 % to 21.13%.

Analysis 2. CAPEX versus Grant over revenues

	SCEN	1			CAPEX		
	IRR	17.74%	163,108 €	156,016 €	**141,833 €**	127,650 €	120,558 €
		6.60%	17.62%	18.43%	20.21%	22.25%	23.39%
		5.50%	17.25%	18.04%	19.80%	21.82%	22.94%
Grant over		**5.00%**	17.08%	17.87%	19.61%	21.62%	22.74%
sales		4.50%	16.91%	17.69%	19.43%	21.42%	22.53%
		4.00%	16.73%	17.52%	19.24%	21.22%	22.33%

Table 49. UC5. CAPEX versus Grant

A 5% of grant moves the IRR from 17.74 % to 19.61 % for the same CAPEX.

Analysis 3. CAPEX versus operation costs

	SCEN	1			CAPEX		
	IRR	17.74%	163,108 €	156,016 €	141,833 €	127,650 €	120,558 €
		8,423.1	14.83%	15.56%	17.18%	19.02%	20.05%
		8,056.9	15.01%	15.74%	17.37%	19.22%	20.26%
Operation		7,324.5	15.36%	16.10%	17.74%	19.62%	20.67%
Cost		6,592.0	15.70%	16.46%	18.12%	20.02%	21.08%
		6,225.8	15.88%	16.64%	18.31%	20.22%	21.29%

Table 50. UC5. CAPEX versus Operational Costs

A 15% decrease in operational costs improve the IRR from 17.74 % to 18.31%.

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8 USE CASE 6. LOW POWER DC BIDIRECTIONAL CHARGING INFRASTRUCTURE FOR EV, INCLUDING TWO-WHEELERS

8.1 Description

8.1.1 UC6 description

A highly replicable use case along Europe which can be achieved through the development of controllable Low power bi-directional CHAdeMO and CCS DC chargers (V2X) with an output power between 7,4 kW – 25 kW per vehicle, integrated in a DC micro grid. Additionally, a theft proof charging station rack for shared bicycles or other two wheeled vehicles, with an output power ranging from 120 W up to 3,4 kW to charge multiple bikes at the same time will be disposed in parallel to the rest of charging points.

The system will be able to integrate AC/DC converters for the connection of RES and ESS in the same DC bus to reduce the energy needed from the grid and manage the peak load, as well as to enable its easy scale-up. Instead of using one low power AC/DC converter for each low power DC/DC converter, CIRCE has integrated one 25 kW AC/DC converter connected to various low-medium power DC/DC converters.

Some relevant components of the value proposition are:

- Vehicle charging optimization
- Trading between office/home installations and EVs
- P2P market between vehicles
- Secure DC racks for LEV

Among the main objectives in UC6, it can be highlighted the bidirectional recharge. This UC6 is not only intended to demonstrate that the installation of V2G chargers is feasible, but also the feasibility of supporting the network with these systems as well.

In search of facilitating the consumption of electric transport for society, another of the fundamental objectives is to demonstrate that it is possible to develop chargers for both EVs and low-power two-wheeled vehicles, such as bicycles, at a low cost in the same equipment. In this way, the door is left open to the industrialization of these chargers.

This UC intends integrates SiC semiconductor technology which allows higher power transfer with high efficiency.

8.1.2 Business case

As mentioned, the business case tries to demonstrate the development of controllable Low power bi-directional CHAdeMO and CCS DC chargers (V2X) with an output power between 7,4 kW – 25 kW per vehicle, integrated in a DC micro grid. The system will be also connected to a theft proof charging station rack with two CPs for e-bicycles, or s-scooters, with an output power ranging from 120 W up to 3,4 kW. This Business

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Model is not considering V2G applications, only EV charging. Further schemes and revenue studies for V2G charging and discharging are required.

The assumptions are shown in the following table,

	2030		
Lifetime of equipment	15	years	
Amortization	Lineal		
Average charging time EVs	150	minutes	2.5 h
Charging capacity addressed to EVs	24.47	kW	Two cars simultaneuosly
Charging capacity addressed to scooters	0.53	KW	Four scooters simulatneously
TOTAL CHARGING CAPACITY BY LOCATION	25.00	kW	
Efficiency of location	70%	%	
Efficiency Charging process	92%	%	
Maximum charging events per day	9.6	events/day	
Achievable charging events per day	7	events/day	
Achievable charging events per year	**2,453**	events /year	
Total kWh storaged in one charging event	56	kWh	
Total kWh for 100 km	18	kWh	
Total autonomy with one charge event	313	km	

Table 51. UC6. Main assumptions

The 25 kW is distributed among two CPs for cars (12 kW each) plus some power for 4 CPs prepared for e-bicycles or e-scooters.

The assumptions for the scooters are the following

Assumptions **IncitEV**

BATTERY	Nominal		Real
Electric charge	12.6	Ah	8.82
Tension	42	V	31.5
Capacity	**529**	**Wh**	**278**

CONSUMPTION	1 Low Power for 2 wheels	
Intensity	4.2	A
Average tension	31.5	V
Real Power	**131**	W
Charging time	3	h
Time of use	2.1	h
Autonomy	30	
Efficiency	80%	

CONSUMPTION	4 Low Power CPs for 4 Scooters	
Intensity	16.7	A
Average tension	31.5	V
Real Power	**526**	W

Scooter main features		
Speed	**18**	km/h
Weight user	75	kg
Weight Scooter	15	kg
Unevenness	0%	Asfalto
Exposed surface	0.6	m2

POWER REQUIREMENTS		
Rolling power	110.2	W
Power by aerodynamic drag	21	W
Power to overcome slopes	0	W
Total Power	**131**	**W**

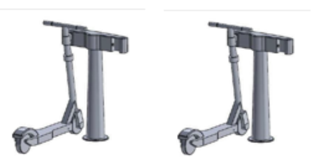

Table 52. UC6 Assumption for e-scooters

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The total power requirements for the e-scooters, although could be more in case of bicycles was calculated as follows:

Assuptions Energy and Power requirements to charge the scooters		
Number of scooters	4.00	units
Time to charge	3.00	h
Time for use	2.11	h
Time to move to Headquarter	0.89	h
Max Charge/day /scooter	4.00	times
Max Charges/day	16.00	Events
Efficiency location	0.75	
Charges per day	12.00	Events /day
Energy Consumed /day (4 scot.)	4.73	kWh/day
% Charging at CS	95%	
Energy consumed in CS /year	1,641	kWh/y
Power Required	**0.53**	kW

Table 53. UC6. Power requirements for 4 CPs addressed to two-wheels electric vehicles

The total driving events according to driving habits were calculated as follows:

	TOTAL CHARGING CAPACITY BY HABITS					2025		
Km/day	**Driver habits**	**2025**		**Event/week**	**Event/year**	**%charger**	**Per year**	
40	Weekly charge events by home cars	280	km/week	1	52	4.00%	2.08	events /year/EV
275	Weekly sup/events for proffessionals	1,925	km/week	6	313	5.00%	15.65	events /year/EV
	Weeks per year	52.14	weeks				**17.73**	events /year/EV
	Days per year	365	days					

Table 54. UC6. Charging habits for the EVs in the opportunity chargers

8.1.3 Key business roles

In UC6, the value network (see D9.1) shows that the most critical stakeholder is the Charging Point Operator, who plays several roles.

From the infrastructure viewpoint, the CPO could buy and install the low-power bidirectional chargers using its own resources, but it could also be the parking space owner who finance that infrastructure and sells the rights to use it including the parking space (asset as a service) to the CPO.

From the energy perspective, the CPO acts as the coordinator and aggregator of energy flows and flexibility services. It buys energy from the utilities to meet the base demand of the charging points, but it also buys

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the renewable energy produced by the solar panels installed by the parking owner or the energy stored in the EVs of the end users. Those energy flows can be aggregated and managed to sell grid services to the DSO.

This use case enables multiple possibilities for end users to be in control of their EV and generate revenue streams. This business model could be applicable to cars and light vehicles sharing companies. In that case, the business model could be profitable. Nevertheless, in our analysis, it was considered that the EV CPs were used aleatory by any citizen, whilst the CPs for the light vehicles was part of a business to share e-scooters with high occupancy with around 12 charging events per day of 3 hours each for the 4 e-scooters.

8.2 Revenue model

Despite the multiple business cases and potential revenue streams that can be leveraged from the technology demonstrated in UC6, the revenue model implemented in this analysis was based on the energy consumed by the end user.

In the future, the possibility to pay for the parking space in urban areas, and the addition of a premium to access the low-power charging infrastructure, could be assessed. It would also be interesting to analyse how electric bicycle rental companies would benefit and what revenue model (based on number of bicycles, time, energy…) would be the most adequate for them.

8.3 Pricing strategy

The pricing strategy in this UC6 is, as in the previous cases, based on the cost of electricity (fixed power concept and variable energy concept). The electricity cost is computed together with other cost components such as asset amortization, personnel, etc. and shared among the total expected customers, adding a profit margin.

Although the current approach is reasonable, a more detailed pricing fixation analysis would be convenient in the future, quantifying the willingness to pay for the service provided, and using dynamic pricing strategies. There is always a minimum price that guarantee the breakeven between incomes and costs. From that point, some pricing strategies could be designed confirming the maximum price accepted by the users where there is not a deep reduction of the service.

8.4 Financial model UC6

The complete revenues' projection can be found in the Excel attached for UC6. These projections have been calculated for years 2025, 2030 and 2035, although 2030 is the year selected for the sensitivity analysis. The projection is made for 15 years by default which is the period set for the depreciation of the asset although it could be extended or reduced. The revenues are subject to be inflated (0% by default) and have been calculated out of VAT. In the initial assumptions, the number of charging events that happens in the Opportunity Charging facility from the total, a home user or a professional make in a year, have been set in 3% and 4% respectively. This is aligned with the percentages indicated in several articles of the use of the public chargers, as users prefer to charge at home or in the offices. Then, depending on the complete fleet of EVs in the city there will be a limitation of charging event by capacity but also by the existing vehicles. The market fix the maximum number of charging events until the full capacity is reached.

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8.4.1 Revenue projections UC6

In the initial assumptions, the selling prices, the electricity costs and other variable costs decrease 1% per year whilst OPEX and other fix costs decreases by 2% annually. This assumption can be modified but it is expected a cost and prices reduction due to the higher penetration of the Renewables. Costs will drop more than prices because the economies of scale effect will be produced, and the learning curve will also allow it. However, prices will not reflect completely this trend trying to improve the profitability and recover some investments that were very compromised at the early stages.

REVENUES	2030		1	2	3	4	5
Flag 2030			1	1	1	1	1
Year		Total	2030	2031	2032	2033	2034
Total Revenues Charger	**€**	**498,359**	**35,612**	**35,256**	**34,903**	**34,554**	**34,209**
Sales of electricity without VAT	**€**	**498,359**	**35,612**	**35,256**	**34,903**	**34,554**	**34,209**
Fare (without VAT)	€/MWh		254.9	252.3	249.8	247.3	244.9
Volume	MWh		140	140	140	140	140
Grants			**0**	**0**	**0**	**0**	**0**
Amortization	15	years					

Table 55. UC6. Revenues projection from 2030 onward (partial data of 5 years)

8.4.2 OPEX projections UC6

The OPEX table includes the total costs of goods sold (COGS) and General Expenses (SG&A). The COGS adds fix costs (operation and maintenance, other fix costs like the power component of the tariff and disposal costs) and variable costs (electricity costs, which depends on costs of electricity and volume, and other compensation costs). Electricity costs are reduced a 2% yearly due to the penetration of Renewables, although this variable can be modified. All the figures are out of VAT and are set with an inflation rate of 0% although this assumption can be also modified in the "Assumption tab". The OPEX table also shows the depreciation of the assets (including the upfront costs to manufacture the infrastructure (year 2029), the depreciation of the equipment for billing and communication (year 2030) and the renewal costs after 7 years with a value equivalent to 35 % of the initial upfront costs.

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OPEX	2030	1	2	3	4	5
Flag 2030		1	1	1	1	1
Year		**2,030**	**2,031**	**2,032**	**2,033**	**2,034**
Total Costs of Goods sold	**€**	**(20,717)**	**(20,391)**	**(20,071)**	**(19,757)**	**(19,448)**
Variable Costs	**€**	**(8,577)**	**(8,492)**	**(8,407)**	**(8,323)**	**(8,239)**
Compensation excedents in production (+)	**€**	**(1,672)**	**(1,655)**	**(1,638)**	**(1,622)**	**(1,606)**
Cost per unit	€/MWh	(12.0)	(11.8)	(11.7)	(11.6)	(11.5)
Volume	MWh /y	140	140	140	140	140
Othe variable (Social bonus, rental meter)	**€**	**(3,059)**	**(3,028)**	**(2,998)**	**(2,968)**	**(2,938)**
Cost per unit	€/month	(254.90)	(252.35)	(249.82)	(247.33)	(244.85)
Volume	month	12	12	12	12	12
Electricity costs	**E**	**(3,847)**	**(3,808)**	**(3,770)**	**(3,733)**	**(3,695)**
Cost per unit	€/MWh	(27.53)	(27.26)	(26.99)	(26.72)	(26.45)
Volume	MWh	140	140	140	140	140
Fix Costs		**(11,638)**	**(11,408)**	**(11,182)**	**(10,962)**	**(10,745)**
O&M Costs	**€**	**(11,349)**	**(11,122)**	**(10,899)**	**(10,681)**	**(10,468)**
Operational Costs	€	(7,168)	(7,025)	(6,884)	(6,747)	(6,612)
Maintenance costs		(4,181)	(4,097)	(4,015)	(3,935)	(3,856)
Transport and distribution (Power term)	**€**	**(289)**	**(286)**	**(283)**	**(280)**	**(278)**
Power Term fix costs		(288.92)	(286.03)	(283.17)	(280.34)	(277.54)
Disposal costs	**€**	-	-	-	-	-
Disposal costs		-	-	-	-	-
SG&A and other costs	**€**	**(502)**	**(492)**	**(482)**	**(472)**	**(463)**
Lifetime	15					

Table 56. UC6. OPEX projections from 2030 onward (partial data of first 5 years)

8.4.3 Profit and losses UC6

The Excel “Profit and Losses” tab includes the profit and losses account (in 2025, 2030 and 2035), till the “net incomes” line. No third parties financing is included. It also shows the “free cash flow”, with the calculation of the NPV and the IRR, for a WACC of 6.5% equal for all the pilots to allow an easy comparison and finally there is a “taxes” table. The depreciation of the assets calculated in D9.4 and the occupancy are the main factors affecting the profitability of the model.

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PROFIT AND LOSS ACCOUNT		2030		1	2	3	4	5
				1	1	1	1	1
YEAR			2029	2030	2031	2032	2033	2034
Revenues Sales of electricity	€			35,612	35,256	34,903	34,554	34,209
Public grant	€			-	-	-	-	-
Total Revenues	€		-	35,612	35,256	34,903	34,554	34,209
COGS	€			(20,717)	(20,391)	(20,071)	(19,757)	(19,448)
SG&A and other costs	€			(502)	(492)	(482)	(472)	(463)
	€							
	€							
Total Expenses	€		-	(21,219)	(20,883)	(20,553)	(20,229)	(19,910)
EBITDA	**€**		**-**	**14,393**	**14,373**	**14,350**	**14,325**	**14,298**
Depreciation and amortisation	€			(8,415)	(8,415)	(8,415)	(8,415)	(8,415)
	€							
EBIT	**€**		**-**	**5,979**	**5,958**	**5,936**	**5,911**	**5,884**
P&L interest expenses	€							
Taxes	€			-	-	-	-	-
Other	€							
Net Income / Loss	**€**		**-**	**5,979**	**5,958**	**5,936**	**5,911**	**5,884**
				16.79%	16.90%	17.01%	17.11%	17.20%
Free Cash Flow								
EBIT	**€**		**-**	**5,979**	**5,958**	**5,936**	**5,911**	**5,884**
Depreciation and amortisation	€			8,415	8,415	8,415	8,415	8,415
CAPEX			(131,456)					
FREE CAS FLOW UNLEVELIZED	**€**		**(131,456)**	**14,393**	**14,373**	**14,350**	**14,325**	**14,298**

NPV	**1,250 €**
IIR	**6.6%**
WACC	**6.5%**
Lifetime	**15**

Table 57. UC6. Profit and Losses Account from 2030 onward (partial data of first 5 years)

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8.4.4 Final Results UC6.

The summary of results is shown in the next table for infrastructure set up in years 2025, 2030 or 2035. Initial results reflect that in all cases the IRR is far slightly below the WACC, for the assumptions taken. However, we do believe that this model could be profitable if the occupancy/rotation is guaranteed.

Additional revenues can be provided by enabling the V2G capabilities of this chargers. As for 2024, limited EVs are ready for V2G, but this should change in the following years. *It is expected that EV users using V2G services will be able to charge their batteries for free.*

ZARAGOZA (UC6. SPAIN 25 KW V2G charger (2 CP EV + 4 CPs Scooters) Conductive				
		2,025	**2,030**	**2,035**
P&L				
TOTAL Sales	€	37,447	35,612	33,867
TOTAL Expenses	€	(20,941)	(21,219)	(19,096)
EBITDA	€	16,506	14,393	14,771
NET INCOMES	€	7,220	5,979	7,143
KPIs				
NPV	€	(32,595)	1,250	(11,259)
IRR	%	6.0%	6.6%	9.0%
WACC	%	6.5%	6.5%	6.5%
Lifetime		15	15	15
Inflation FLAG	NO			

Table 58. UC6. Results for years 2025, 2030 and 2035

8.4.5 Sensitivity UC6

The sensitivity analysis allows to compare multi-variables or a couple of variables together and see how the NPV or the IRR evolve. This study may reflect how sensible is the model to the different factors. The calculation possibilities are enormous, so a combination of factors has been estimated that, in our opinion, are the most decisive in making the project profitable, but some other are possible.

8.4.5.1 Multivariable Sensitivity UC6

The explanation on how the multivariable and dual variable analysis works can be found in the Excel sheet linked to the report (UC6 Zaragoza).

The table is fed with some data (CAPEX, OPEX and other Economic Indexes (like inflation, WACC or percentage for SG&A) and also some other factors like the efficiency of location, the efficiency of the charging process, the % of charging events by home users and or professionals and the prices and grants. Then, the table provide at the end the Net Present Value (NPV) and the Internal Rate of Return (IRR) or profitability of the business. The scenarios aside allow the modification of these variables obtaining new values for the NPV and the IRR

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Table 1. Sensitivity 2030. Select Scenario — In Scenarios 2 to 4, play with the percentages, not numbers, in 5 to 7 modify numbers

UC6. SPAIN 25 KW V2G charger (2 CP EV +4 CPs Scooters)	1	UNITS	1 SCE base		2 SCE 2		3 SCE 3		4 SCE 4	5 SCE 5	6 SCE 6	7 SCE 7
COSTS												
CAPEX	Don`t touch		Don`t touch									
CAPEX Infrastructure	115,916	€	115,916	-10%	104,324	10%	127,508	-10%	104,324	115,916	115,916	115,916
CAPEX Renewal	9,113	€	9,113	-10%	8,202	10%	10,024	-10%	8,202	9,113	9,113	9,113
Lifetime of Equipment	15	Years	15		15		15		15	15	15	15
OPEX												
Operation Costs year 1	7,168	€/year 1	7,168	-10%	6,451	10%	7,885	-10%	6,451	7,168	7,168	7,168
Maintenance costs year 1	4,181	€/year 1	4,181	-10%	3,763	10%	4,599	-10%	3,763	4,181	4,181	4,181
Cost of electricity	33.32	€/MWh	33.32	-10%	29.99	10%	36.65	-10%	29.99	33.3	33.3	33.3
Transport & Distribution & Chargers	14.48	€/MWh	14.48	-10%	13.03	10%	15.93	-10%	13.03	14.5	14.5	14.5
ECONOMIC INDEXES												
WACC	6.5%	%	6.5%	0%	6.5%	0%	6.5%	0%	6.5%	6.5%	6.5%	6.5%
Inflation prices	0.0%	%	0.0%	0%	0.0%	0%	0.0%	0%	0.0%	0.0%	1.5%	2.0%
Inflation costs	0.0%	%	0.0%	0%	0.0%	0%	0.0%	0%	0.0%	0.0%	2.0%	1.5%
% SG&A and other costs /labour OPEX	7.0%	%	7.0%	0%	7.0%	0%	7.0%	0%	7.0%	7.0%	7.0%	7.0%
OTHER FACTORS												
LOCATION												
Efficiency of location	70.0%	%	70.0%	-10%	63.0%	10%	77.0%	10%	77.0%	70.0%	70.0%	70.0%
Efficiency Charging process	92.0%	%	92.0%	-10%	82.8%	10%	101.2%	10%	101.2%	92.0%	92.0%	92.0%
% Charge events by home users	4.0%		4.0%	-10%	3.6%	10%	4.4%	10%	4.4%	4.0%	4.0%	4.0%
% Charge events for proffessionals	5.0%	h	5.0%	-10%	4.5%	10%	5.5%	10%	5.5%	5.0%	5.0%	5.0%
PRICES												
Conductive Electricity Tariff price	308.43	€/Mwh y 1	308.43	-10%	277.58	10%	339.27	10%	339.27	308.43	339.27	339.27
Grant over sales of electricity	0.0%	%	0.0%	0%	0.0%	0%	0.0%	0%	0.0%	5.0%	0.0%	5.0%
RESULTS												
NPV	1,250	€	1,250		(45,337)		63,671		120,573	17,051	31,601	52,007
IRR (post tax)	6.65%	%	6.65%		-0.22%		12.97%		20.36%	8.50%	10.12%	12.32%

Table 59. UC6. Sensitivity Analysis 2030

Scenario 1. The conditions are those of the base case in year 2030. IRR reflects 6.65 % slightly over the WACC (6.5%)

Scenario 2. CAPEX and OPEX are decreased 10% and efficiency of location, efficiency of charging process, % charging events by home users and professionals in Opportunity chargers are also decreased a 10%. The result is worst with an IRR of -0.22%

Scenario 3. CAPEX and OPEX are increased 10% and efficiency of location, efficiency of charging process, % charging events by home users and professionals in Opportunity chargers are also increased a 10%. The result is better with an IRR of 12.97 %.

Scenario 4. CAPEX and OPEX are decreased 10% but efficiency of location, efficiency of charging process, % charging events by home users and professionals in Opportunity chargers are increased a 10%. The result is clearly above the WACC with an IRR of 20.30%

Scenario 5. Same conditions than scenario 1, but a 5% of grant over the electricity revenues, deriving in an 8.50 % IRR.

Scenario 6. Same conditions than scenario 1 but increasing prices of electricity by a factor of 10%. IRR 10.12%

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Scenario 7. Same conditions than scenario 1 but increasing prices of electricity by a factor 10% and providing a grant of 5% over the electricity revenues. IRR over the WACC 12.32 %.

8.4.5.2 Dual variable Sensitivity UC6

For the dual variable analysis, two factors are selected and modified a 10% and 15% up and down. Then, the sensitivity is applied, and the IRR is modified for each couple of values. A color code reflects the results; the greener the most profitable, the red the less.

The following comparisons have been implemented:

Analysis 1. CAPEX versus conductive prices. Wireless prices are those for conductive equivalent power values, multiplied by a factor that it is 1 by default. Usually, wireless prices per MWh should be slightly over those for conductive.

	SCEN	1			CAPEX		
	IRR	**6.65%**	133,303 €	127,508 €	**115,916 €**	104,324 €	98,529 €
		354.7 €	9.29%	9.99%	11.53%	13.32%	14.32%
		339.3 €	7.83%	8.50%	9.96%	11.65%	12.60%
Conductive		**308.4 €**	4.74%	5.34%	6.65%	8.15%	8.99%
Prices		277.6 €	1.30%	1.83%	2.99%	4.32%	5.05%
		262.2 €	-0.61%	-0.11%	0.97%	2.20%	2.89%

Table 60. UC6. Dual Analysis. CAPEX versus Conductive prices

Electricity prices can modify greatly the results. A 15% up in prices provides an 11.53% IRR instead of a 6.65% with the same CAPEX

Analysis 2. CAPEX versus Grant over revenues

	SCEN	1			CAPEX		
	IRR	6.65%	133,303 €	127,508 €	**115,916 €**	104,324 €	98,529 €
		6.60%	7.00%	7.65%	9.07%	10.71%	11.62%
		5.50%	6.63%	7.27%	8.68%	10.29%	11.20%
Grant over		**5.00%**	6.46%	7.10%	8.50%	10.10%	11.00%
sales		4.50%	6.30%	6.93%	8.32%	9.91%	10.80%
		4.00%	6.13%	6.75%	8.13%	9.72%	10.61%

Table 61. UC6. Dual Analysis. CAPEX versus Grant

The impact of the Grants is not so acute with a slight increase of WACC over the situation of no grant (from 6.65 % with no Grant) to 8.50 % with 5% Grant.

Analysis 3. CAPEX versus maintenance costs

	SCEN	1			CAPEX		
	IRR	6.65%	133,303 €	127,508 €	115,916 €	104,324 €	98,529 €
		4,807.7	4.15%	4.73%	6.01%	7.48%	8.30%
		4,598.7	4.34%	4.93%	6.23%	7.71%	8.54%
Maintenance		4,180.6	4.74%	5.34%	6.65%	8.15%	8.99%
Cost		3,762.6	5.13%	5.73%	7.07%	8.60%	9.45%
		3,553.5	5.32%	5.93%	7.28%	8.81%	9.68%

Table 62. Dual Analysis. CAPEX versus maintenance costs

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The increase of Maintenance costs 15% up or down do not affect strongly the IRR with a variation of less than 1% points up or down.

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9 USE CASE 7. STATIC INDUCTIVE CHARGING

9.1 Description

9.1.1 UC7 description

This UC7 is led by CIRCE and the pilot was set up close the Zaragoza train station. The demonstrator addresses the challenge to demonstrate an static wireless charging system with V2G capabilities for taxi drivers when the wait for clients at the station. A target is to improve the performance of the static inductive charging in terms of misalignment and increasing the power transfer up to 50 kW at frequencies in the range of 70-90 kHz. In this way, it is shown that induction technology can compete with conductive charge in terms of transmitted power. This application is especially convenient on public transport, where it allows avoiding service interruptions, taking advantage of stop periods and decreasing the battery required sizes.

This UC also integrates SiC semiconductor technologies in its demonstrator, enabling a high potential to develop new functionalities and applications.

9.1.2 Business case UC7

The complete system consists of a single unit of 50 kW/85 kHz inductive charger, formed by the electromagnetic system, which function is to transmit power through the phenomenon of electromagnetic induction through a coil; power electronics, which feeds the inductive system through a control system; and the cooling system that evacuates the excess heat generated in the electromagnetic system.

The electromagnetic system is placed in a manhole below the ground level, in such a way that the car to be charged (with the secondary system installed in its underside) is positioned above the transmitter coil. The control detects the receiving coil of the car and activates the power electronics that feed the transmitting coil. This is when the charging process begins.

From the manhole, where the electromagnetic system is located, a tube comes out, which branches into two: one of them carries the electrical cables to the electronics cabinet, and the other carries the liquid cooling tubes to the cabinet of the refrigeration system.

Considering a consumption of 0.171 KWh/km and the 50 kW power rating of the charger, a taxi will be able to charge 11.5 kWh in 15 min (a typical taxi stop) allowing the car to drive for 67 extra km.

Taxis have to be adapted for wireless charging. We assume that the cost of acquisition or adaptation of the electric taxi to be compatible with static wireless charging will be paid by the taxi owner.

Some relevant components of the value proposition are:

- Interoperable high frequency wireless charger ensuring high efficiency performance
- V2G ready capabilities
- Seamless user charging experience

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The main assumptions of this UC7 are described below:

OWPT Power	**50**	kW
Transmission efficiency	92%	
Net power transferred	46	kW
Charging time	0.25	h
Energy charged	11.5	kWh
Average EV consumption (Nissan Leaf electric)	17.1	kWh/100 km
Total autonomy with one charge event	67	km
Electric Vehicles with OWPT		
Vehicles adapted to OWPT (year 1)	20	
Yearly Growth of Taxis equipped with OWPT (accounted every 5)	5%	
Infrastructure depreciation period	15	years
Maintenance Equipment depreciation	7	years

Table 63. UC7. Main assumptions

It was assumed a minimum fleet of 20 taxis equipped with the onboard OWPT system. These taxis make the route to the train station and stop at the OWPT twice a day for 15 minutes each time. The occupancy of the Opportunity charger of 50 kW is considered 50% that from a maximum of 30 Charging events per day represents 15 Charging events per day. Every five year the fleet grows a 25% over year four. At same time the occupancy grows a 5% also each five years over the immediately preceding year. The fleet is kept constant in number for five years.

9.1.3 Key business roles

In UC7, there are two nuclear value chains and stakeholders.

On the one hand, the mobility service information providers develop apps for electro-mobility providers that centralize the service activation for end-users (i.e., interoperable access to the charging session and payment using an app) and provide a decision support tool (DSS) to the public authorities that develop mobility plans and give licenses to motorways and taxi stops.

On the other hand, the Charging Point Operators receive the static wireless charging system that has been developed thanks to the collaboration of academia, technology providers and manufacturers. The CPO manages the energy and communications supplies to construct and operate a static wireless charger with status and cost monitor capability. This infrastructure is offered to electro-mobility providers and DSOs. The former will monetise the infrastructure by selling charging sessions to end-users, while the later will could use V2G technology.

The model assumes that the infrastructure belongs to the charging point operator, who also is responsible for the provision of charging services to the electric taxis.

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9.2 Revenue model

As it is technically possible to measure the energy received by the EV with the designed static inductive charger, the revenue based on the actual energy transfer may be the most convenient in this case and the most attractive for the taxi drivers.

Considering that the operation and management of an individual taxi or a fleet of taxis usually lead to a routine that repeats daily, the charging infrastructure business could be interested in capturing a long-term portfolio of clients through a subscription model, that may be more adequate than pay-per-use to achieve higher customer loyalty.

9.3 Pricing strategy

Any of the pricing strategies listed in chapter 2 could be correct but, for the financial model, the pricing is fixed based on the market, with the possibility to add a premium for the added convenience of the innovative charging system. The objective is to reduce the risk of fixing a non-competitive price. Nevertheless, a more detailed pricing fixation analysis would be required in the future, quantifying the willingness to pay of Use Case and the service provided.

9.4 Financial model UC7

This model could be profitable as the investment (CAPEX) of the installation is relatively cheap compared to the other wireless options, the energy transfer is high because the vehicles don't move and receive the energy in static position and a very good rotation can be easily achieved, especially if an agreement is signed between the CPO and the taxi company/ies. The model proposes a private use of the Charging Point to guarantee that it is relatively free for the taxi drivers who can organise themselves to charge correlatively.

9.4.1 Revenue projections UC7

The complete revenues' projection can be found in the Excel attached for UC7. These projections have been calculated for years 2030 and 2035, although 2035 is the year selected for the sensitivity analysis. The projection is made for 15 years by default which is the period set for the depreciation of the asset although it could be extended. The revenues are subject to be inflated (0% by default) and have been calculated out of VAT. In the initial assumptions, the number of EVs equipped with OWPT is being increased 25% from 2030 onward every five years, although the fare is reduced 1% yearly. Fix costs (operation and maintenance and other fix costs associated to the power term are reduced a 2% annually. All these assumptions can be modified. There is a line for Grant (or any other incentive) initially set at zero.

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REVENUES		2035	1	2	3	4	5
Flag 2030			1	1	1	1	1
Year			2035	2036	2037	2038	2039
Total Revenues	€		**32,624**	**32,298**	**31,975**	**31,655**	**31,339**
Sales of electricity without VAT	€		**32,624**	**32,298**	**31,975**	**31,655**	**31,339**
Fare (without VAT)	€/MWh		411.2	407.1	403.1	399.0	395.0
Volume	MWh		79	79	79	79	79
Grants			**0**	**0**	**0**	**0**	**0**
Amortization		15					

Table 64. UC7. Revenues projection from 2035 onward (partial data of first 5 years)

9.4.2 OPEX projections UC7

The OPEX table includes the total costs of goods sold (COGS) and General Expenses (SG&A). The COGS adds fix costs (operation and maintenance, other fix costs like the power component of the tariff and disposal costs) and variable costs (electricity costs, which depends on costs of electricity and volume, and other compensation costs). Electricity costs are reduced a 2% yearly due to the penetration of Renewables, although this variable can be modified. All the figures are out of VAT and are set with an inflation rate of 0% although this assumption can be also modified in the “Assumption tab”. The OPEX table also shows the depreciation of the assets (including the upfront costs to manufacture the infrastructure (year 2034), the depreciation of the equipment for billing and communication (year 2035) and the renewal costs after 7 years with a value equivalent to 35 % of the initial upfront costs.

OPEX		2035	1	2	3	4	5
Flag 2030			1	1	1	1	1
Year			2,035	2,036	2,037	2,038	2,039
TOTAL COST OF GOLDS SOLD	€		**(15,877)**	**(15,598)**	**(15,324)**	**(15,056)**	**(14,792)**
FIX COSTS			**(12,291)**	**(12,052)**	**(11,819)**	**(11,590)**	**(11,365)**
Operation Costs	€		(6,463)	(6,334)	(6,207)	(6,083)	(5,961)
Maintenace Costs	€		(5,085)	(4,983)	(4,883)	(4,786)	(4,690)
Other fix costs	€		(743)	(736)	(728)	(721)	(714)
	€		-	-	-	-	-
VARIABLE COSTS			**(3,134)**	**(3,102)**	**(3,071)**	**(3,041)**	**(3,010)**
Electricity costs	E		**(2,184)**	**(2,163)**	**(2,141)**	**(2,120)**	**(2,098)**
Cost per unit	€/MWh		(27.53)	(27.26)	(26.99)	(26.72)	(26.45)
Volume	MWh		79	79	79	79	79
Compensation excedents in production (+)	€		**(949)**	**(940)**	**(930)**	**(921)**	**(912)**
Cost per unit	€/MWh		(12.0)	(11.8)	(11.7)	(11.6)	(11.5)
Volume	MWh /y		79	79	79	79	79
SG&A	€		**(452)**	**(443)**	**(434)**	**(426)**	**(417)**
Depreciation	€		**(5,210)**	**(5,210)**	**(5,210)**	**(5,210)**	**(5,210)**
Lifetime		15					

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9.4.3 Profit and losses UC7

PROFIT AND LOSS ACCOUNT	2035		1	2	3	4	5
			1	1	1	1	1
YEAR		2034	2035	2036	2037	2038	2039
Revenues Sales of electricity	€		32,624	32,298	31,975	31,655	31,339
Public grant	€		-	-	-	-	-
REVENUES	**€**	**-**	**32,624**	**32,298**	**31,975**	**31,655**	**31,339**
COGS	€		(15,877)	(15,598)	(15,324)	(15,056)	(14,792)
SG&A and other costs	€		(452)	(443)	(434)	(426)	(417)
EXPENSES	**€**	**-**	**(16,329)**	**(16,041)**	**(15,759)**	**(15,482)**	**(15,210)**
EBITDA	**€**	**-**	**16,295**	**16,257**	**16,216**	**16,174**	**16,129**
Depreciation and amortisation	€		(5,210)	(5,210)	(5,210)	(5,210)	(5,210)
EBIT	**€**	**-**	**11,085**	**11,047**	**11,006**	**10,964**	**10,919**
P&L interest expenses	€						
Taxes	€		(2,771)	(2,762)	(2,752)	(2,741)	(2,730)
Other	€						
Net Income / Loss	**€**	**-**	**8,314**	**8,285**	**8,255**	**8,223**	**8,189**
			25.48%	25.65%	25.82%	25.98%	26.13%

Free Cash Flow

YEAR		2029	2030	2031	2032	2033	2034
EBIT	**€**	**-**	**11,085**	**11,047**	**11,006**	**10,964**	**10,919**
Depreciation and amortisation	€		5,210	5,210	5,210	5,210	5,210
CAPEX		**(86,412)**					
FREE CAS FLOW UNLEVELIZED	**€**	**(86,412)**	**16,295**	**16,257**	**16,216**	**16,174**	**16,129**

NPV	**73,915 €**
IIR	**17.74%**
WACC	**6.5%**
Lifetime	**15**

Table 66. UC7. Profit and Losses account for 2035

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9.4.4 Final results UC7

The summary of results is shown in the next table for infrastructure set up in years 2030 or 2035. Initial results reflect that this business model could be easily profitable once the occupancy will be assured and a number of taxis (at least 20 will be equipped with the system)

ZARAGOZA Use Case. UC7. 50 kW Opportunity Static Wireless charging (OSWC) Inductive			
		2,030	**2,035**
P&L			
TOTAL Sales	€	32,672	32,624
TOTAL Expenses	€	(17,860)	(16,329)
EBITDA	€	14,812	16,295
NET INCOMES	€	6,337	8,314
KPIs			
NPV	€	43,276	73,915
IRR	%	12.25%	17.74%
WACC	%	6.5%	6.5%
Lifetime		15	15
Inflation FLAG	NO		

Table 67. UC7 Final results

9.4.5 Sensitivity

9.4.5.1 UC7. Multivariable analysis

The sensitivity analysis allows to compare multi-variables or a couple of variables together and see how the NPV or the IRR evolve. This study may reflect how sensible is the model to the different factors. The calculation possibilities are enormous, so a combination of factors has been estimated that, in our opinion, are the most decisive in making the project profitable but some other are also possible.

The scenarios prepared have been the following:

- **Scenario 1**. The conditions are those of the base case in year 2035. IRR reflects 17.74 % above the WACC (6.5%) with a good profitability.
- **Scenario 2**. CAPEX and OPEX are decreased 10% and occupancy and transmission efficiency are also decreased a 10%. The result is worst with an IRR of 9.82 %
- **Scenario 3**. CAPEX and OPEX are increased 10% and occupancy and transmission efficiency are also increased a 10%. The result is much better with an IRR of 25.94 %.
- **Scenario 4**. CAPEX and OPEX are decreased 10% but occupancy and transmission efficiency are increased a 10%. The result is clearly above the WACC with an IRR of 34.77%

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- **Scenario 5**. Same conditions than scenario 1, but a 5% of grant over the electricity revenues, deriving in a 17.54 % IRR.
- **Scenario 6**. Same conditions than scenario 1 but increasing prices of electricity by a factor 10%. IRR 18.75 %
- **Scenario 7**. Same conditions than scenario 1 but increasing prices of electricity by a factor of 10% and providing a grant of 5% over the electricity revenues. IRR over the WACC 20.67 %.

ZARAGOZA. Use Case. UC7. 50 kW	Select Scenario			Scenarios 2 to 4, play with the percentages, not numbers, in 5 to 7 modify numbe								
Opportunity Static Wireless charging (OSWC	1		1		2		3		4	5	6	7
Sesitivity 2035		UNITS	SCE base		SCE 2		SCE 3		SCE 4	SCE 4	SCE 4	SCE 4
COSTS												
CAPEX	Don`t touch		Don`t touch									
Charging Infrastructure	65,891	€	65,891	-10%	59,302	10%	72,481	-10%	59,302	65,891	65,891	65,891
Lifetime of Equipment	15	Years	15		15		15		15	15	15	15
OPEX												
Operation Costs year 1	6,463	€/year 1	6,463	-10%	5,817	10%	7,109	-10%	5,817	3,073	3,073	3,073
Maintenance costs year 1	5,085	€/year 1	5,085	-10%	4,576	10%	5,593	-10%	4,576	3,277	3,277	3,277
Cost of electricity	33.3	€/MWh	33.3	-10%	30.0	10%	36.6	-10%	30.0	56.8	56.8	56.8
ECONOMIC INDEXES												
WACC	6.5%	%	6.5%	0%	6.5%	0%	6.5%	0%	6.5%	6.5%	6.5%	6.5%
Inflation prices	0.0%	%	0.0%	0%	0.0%	0%	0.0%	0%	0.0%	0.0%	0.0%	0.0%
Inflation costs	0.0%	%	0.0%	0%	0.0%	0%	0.0%	0%	0.0%	0.0%	0.0%	0.0%
% SG&A and other costs /labour OPEX	7.0%	%	7.0%	-10%	6.3%	10%	7.7%	-10%	6.3%	7.0%	7.0%	7.0%
OTHER FACTORS												
LOCATION												
Transmission efficiency	92.0%	%	92.0%	-10%	82.8%	10%	101.2%	10%	101.2%	92.0%	92.0%	92.0%
Occupancy (in %)	70.0%	%	70.0%	-10%	63.0%	10%	77.0%	10%	77.0%	70.0%	70.0%	70.0%
CHARGING EVENTS AND EVs EQUIPPED												
Maximum nº of charging events /day/charger	30	UNITS	30	-10%	27	10%	33	10%	33	30	30	30
Yearly Growth EVs equipped with OWPT	5.0%	%	5.0%	-10%	4.5%	10%	5.5%	0%	5.0%	5.0%	5.0%	5.0%
PRICES												
Conductive Electricity Tariff price	428.37	€/Mwh year 1	428.37	-10%	385.53	10%	471.21	10%	471.21	365.83	365.83	365.83
Factor (Inductive/Conductive)	1.2	ariff Ind/Con	1.2	0%	1.2	0%	1.2	10%	1.2	1.2	1.3	1.3
Grant over sales of electricity	0.0%	%	0.0%	0%	0.0%	0%	0.0%	0%	0.0%	5.0%	0.0%	5.0%
RESULTS												
NPV	73,915	€	73,915		18,624		145,364		187,936	71,048	79,608	93,519
IRR (post tax)	**17.74%**	%	17.74%		9.82%		**25.94%**		34.77%	**17.54%**	**18.75%**	**20.67%**

Table 68. UC7 Multivariable Sensitivity analysis

9.4.5.2 Dual variable analysis

For the dual variable analysis, two factors are selected and modified a 10% and 15% up and down. Then, the sensitivity is applied, and the IRR is modified for each couple of values. A colour code reflects the results; the greener the most profitable, the red the less.

The following comparisons have been implemented:

Analysis 1. CAPEX versus conductive prices. Wireless prices are those for conductive equivalent power values, multiplied by a factor that it is 1 by default. Usually, wireless prices per MWh should be slightly over those for conductive.

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SCEN	1	CAPEX				
IIR	17.74%	75,775 €	72,481 €	65,891 €	59,302 €	56,008 €
	492.6 €	20.96%	21.83%	23.72%	25.89%	27.10%
	471.2 €	19.16%	19.97%	21.76%	23.80%	24.94%
Conductive	428.4 €	15.45%	16.17%	17.74%	19.53%	20.53%
Prices	385.5 €	11.53%	12.16%	13.53%	15.08%	15.93%
	364.1 €	9.47%	10.05%	11.32%	12.75%	13.54%

Table 69. UC7. CAPEX versus Conductive prices

In year 2035, the analyst concludes that a 15% increase in the conductive price moves the IRR from 17.74% to 23.72%. It is worth mentioned that real prices charged to taxi drivers are the conductive prices multiplied by a factor of 1.2 (in our model). This is the ratio between wireless /conductive prices. This figure can be also modified providing fewer positive results if reduced.

Analysis 2. CAPEX versus Grant over revenues

The grant line is there in case an incentive will be required from the Administrations. In the UC7 business model, results are yet positive, so this grant should not be needed.

SCEN	1	CAPEX				
IIR	17.74%	75,775 €	72,481 €	65,891 €	59,302 €	56,008 €
	6.60%	17.97%	18.75%	20.47%	22.43%	23.52%
	5.50%	17.56%	18.33%	20.02%	21.95%	23.03%
Grant over	5.00%	17.37%	18.13%	19.82%	21.73%	22.80%
sales	4.50%	17.18%	17.94%	19.61%	21.52%	22.57%
	4.00%	16.99%	17.74%	19.40%	21.30%	22.35%

Table 70. UC7. CAPEX versus Grants

A 5% grant over sales, moves up the IRR from 17.74% to 19.82 %, just two points.

Analysis 3. CAPEX versus maintenance costs

SCEN	1	CAPEX				
IIR	17.74%	75,775 €	72,481 €	65,891 €	59,302 €	56,008 €
	5,847.2	14.60%	15.30%	16.82%	18.55%	19.51%
Maintenance	5,593.0	14.88%	15.59%	17.13%	18.88%	19.85%
Costs	5,084.6	15.45%	16.17%	17.74%	19.53%	20.53%
	4,576.1	16.01%	16.75%	18.35%	20.18%	21.20%
	4,321.9	16.29%	17.03%	18.66%	20.51%	21.53%

Table 71. UC7. CAPEX versus maintenance costs

The impact of the Maintenance cost is not so acute with a slight increase of WACC over the situation of initial maintenance figure if you reduce a 15% the maintenance costs (just 1 point in percentage).

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10 CONTRIBUTION TO EXPLOITATION AND DISSEMINATION

Results	Link to WP11: Exploitation results
Business models UC1 to UC7	Provided in open source (excel sheets available in the Web page in results).

Results	Link to WP12: Dissemination results
Business models UC1 to UC7	Technical article compiling the UCs conclusions to be submitted to a technical magazine
	Maybe presentation in a sectorial conference (TBD) after project end

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11 CONCLUSIONS

The INCIT-EV project has assessed various revenue models, pricing strategies and financial models based on charging infrastructure for electric vehicles (EVs).

The Revenues models were primarily focusing on direct revenue from charging fees. The revenue models considered include:

- **Time-Based Models**: Where revenue is proportional to the time the EV is parked at the charging point. This model is advantageous for low-power chargers in urban areas where drivers are accustomed to paying for parking. However, the value provided varies depending on the charging time, the state of charge, and the EV's capacity to charge at the maximum power provided by the charger.
- **Energy-Based Models:** Revenue is proportional to the energy provided to the EV. This model is particularly suitable for high-power chargers located in service areas on highways or places with low parking time. The value provided is more uniform among customers since the parking time should be minimized, and the charging power maximized. Higher power chargers enhance the user experience but are also more expensive.
- **Alternative Models:** These include subscription-based models with fixed or variable fees, or mixed models combining direct and indirect revenue streams, such as income from charging fees and advertising. By analyzing customer preferences, market conditions, and financial projections, businesses can tailor their revenue models to maximize profitability and growth potential. Charging hubs can offer additional services like coffee shops, shops, and connections to other transportation modes, enhancing the user experience and potentially attracting more customers. Some commercial centers offer free charging to attract clients.

Pricing Strategies: Various pricing strategies can be applied, including cost-based pricing, value-based pricing, competitive pricing, and dynamic pricing. Cost-based pricing involves setting prices by adding a margin to the cost, ensuring at least break-even and possibly a profit margin. Value-based pricing sets prices based on the perceived value to customers, considering factors like charging speed, convenience, and location. Competitive pricing adjusts prices based on competitor offerings, while dynamic pricing varies based on demand, energy prices, time of day, and location.

Financial Models: Financial models are crucial for projecting future revenues, expenses, and cash flows to assess the financial viability of new charging solutions. The three-statement model integrates the revenue statement, balance sheet, and cash flow statement into one dynamically linked model. The Discounted Cash Flow (DCF) model calculates the present value of expected future cash flows to determine the project's value. Key components of the financial models include revenue projections, cost structures, and investment requirements.

Some of the horizontal technologies applied in INCIT-EV are Smart Charging, Vehicle-to-Grid (V2G), and Dynamic Grid Balancing: Each of these systems offers distinct economic benefits and challenges for EV users and grid operators. Smart charging optimizes energy use by adjusting charging times to avoid peak demand, reducing electricity costs and enhancing grid stability.

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However, it requires significant initial investment in smart hardware and software. V2G systems allow EVs to discharge power back to the grid, supporting energy storage and offering potential financial incentives. However, they involve higher costs and potential battery degradation. Dynamic grid balancing optimizes energy use and avoids peak rates, reducing overall energy costs and improving the efficiency and reliability of the home's electrical system.

For EV users, **smart charging provides cost savings up to 90%** by charging during off-peak hours, despite the initial investment in advanced equipment. V2G systems offer income opportunities through grid support services but involve higher upfront and maintenance costs and potential battery wear. Dynamic grid balancing helps avoid peak electricity rates and reduces the risk of electrical overloads, making it a worthwhile long-term investment despite significant initial costs.

For grid operators like GOPACS, **smart charging reduces peak demand and operational costs**, though it requires significant investment in advanced metering and control infrastructure. V2G systems balance supply and demand, improving grid reliability and creating new revenue streams, but entail high installation costs and potential battery degradation. Dynamic grid balancing optimizes energy distribution and avoids expensive infrastructure upgrades, though it involves upfront costs for implementation.

The revenue models are similar across these systems, with smart charging and dynamic grid balancing capping power peaks to reduce electricity tariffs and shifting consumption to lower tariff periods. V2G systems require higher investment but provide additional income through grid support services. Companies providing these services can adapt tariffs to maintain equivalent profit margins.

Pricing Strategy for Software Developers: For companies developing software algorithms, like Greenflux and Last Mile solutions, their clients will be grid operators such as GOPACS or other DSOs/TSOs. These operators benefit from reduced total power requirements and grid adaptation costs. The software as a service must offset CAPEX and OPEX, with the savings from reduced investment requirements compensating the service cost.

Use Case Analyses:

UC1a (**Smart Charging**): Citizens will save significantly on electricity costs, and DSOs will see increased EBITDA from reduced operational expenses. **Savings can vary from 40 to 90% for the end user / CPO.**

UC1b (**V2G Systems**): EV users must bear the cost of V2G adaptation and battery degradation, with potential income from grid support services. Savings will depend on dynamic tariffs and battery services regulation. DSOs gain substantial benefits from grid balancing.

UC1c (**Dynamic Grid Balancing** in Private Garages): Similar to UC1a but on a smaller scale, with reduced costs for EV owners through aggregated management.

Use Case 2 (Dynamic Wireless Charging Lane in Urban Area): The pilot system for urban vehicles showed challenges in profitability due to high initial investment and lower IRR compared to WACC. Profitability starts at a minimum **selling price of 0,49 €/kWh in 2035**, a 60% higher than a conductive charger of the same power. This use case is limited by the number of users equipped for wireless charging and the short range of the electrified section and due to the challenges of implementing this type of installation in urban areas.

Use Case 3 (Dynamic Wireless Charging for Long Distance): The business case for a 25-km DWPT track indicated difficulties in achieving profitability, with better results than the urban solution due to lower infrastructure costs. Profitability starts at a minimum **selling price of 0,53 €/kWh in 2035**, a 25% higher than a conductive charger of the same power. This use case may be much more profitable than UC2 because

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infrastructure costs in open areas (highways) are lower than in cities and allow for much longer corridors. The key to making this model work is having enough vehicles traveling daily, which is difficult to achieve.

Use Case 4 (Charging Hub in a Park-and-Ride Facility): This model showed potential for profitability if optimized, benefiting from the trend towards reducing urban pollution and providing alternative transport options. **This is one of the most profitable use cases**, especially if the hub is located on the outskirts of cities, near main arteries, and is established as a node for connections with public transportation, proximity parking, leisure activities (shopping, cafes), and transfers to clean electric vehicles and light vehicles. This type of initiative allows for high turnover in charging, which will very likely make it profitable. **With a selling price of 0,44 €/kWh for 150 kW and 0,31 €/kWh for 3,3 kW chargers the IRR is 27% against 6,5 WACC.**

Use Case 5 (Superfast Charging Systems for European Corridors): Despite the technology's potential to reduce range anxiety, the low occupancy and high investment costs challenge profitability. Ultra-fast chargers on highways could be profitable if grouped in sufficient numbers (e.g., 10 units) and medium voltage access with renewable energy is secured, and if the electric vehicle fleet grows. These chargers are expensive, but in these locations, there are not many alternatives, so some turnover is likely. **With a selling price of 0,42 €/kWh for 200 kW the IRR is 17,7% against 6,5 WACC in 2030.**

Use Case 6 (Low Power DC Bidirectional Charging for EVs and Two-Wheelers): This case demonstrated potential profitability with guaranteed occupancy, leveraging low-cost chargers for various vehicle types. 25 kW quick chargers at strategic points in the city could be profitable for professionals (taxi drivers, delivery drivers, salespeople), especially if located in shopping centers, parking lots, hotels, etc., and preferably with service personnel who can swap cars as they finish charging. The scooter business can be profitable only if a high-turnover service is established in tourist areas, such as within the historic city centers. This BM considers both chargers, V2G and 2-wheelers. **Further V2G schemes and revenue studies are required**. Additional revenues can be provided by enabling the V2G capabilities of this chargers. As for 2024, limited EVs are ready for V2G, but this should change in the following years. *It is expected that EV users using V2G services will be able to charge their batteries for free.*

Use Case 7 (Static Inductive Charging): The pilot for taxi drivers showed that this model could be profitable with assured occupancy and sufficient equipped taxis. This wireless charging model for taxis at waiting points in airports or bus/train stations could be profitable if exclusively targeted to those industries and reasonable charging prices are agreed upon. The infrastructure is not very expensive, and being static, it transfers a lot of energy in a short time, almost like a production system. As always, the key is turnover. **With a selling price of 0,51 €/kWh for 50 kW, just 20% higher than conductive solutions, the IRR is 17% against 6,5 WACC in 2035.**

In conclusion, the INCIT-EV project highlights the potential and challenges of various charging infrastructure models. Each use case demonstrates unique benefits and economic implications for both EV users and grid operators, with profitability largely dependent on occupancy rates, initial investment, and operational efficiency. The adoption of these technologies requires careful consideration of cost structures, revenue models, and market conditions to ensure long-term viability and success.

Hereinafter the summary of economic results:

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BUSINESS MODELS	UC2 500 m	Paris Cent. DWPT	UC3 25 km	Paris Pher. DWPT	UC 4	Turin	Hub 150 kW
INCITEV	UC2. 1-E-Trench 30 kW, 500 m		UC3. 1 E-Corr.r 90 kW power t., 25 km		UC4. 1 Charger 150 kW and 2 chargers 3.6 kW		
	2030	2035	2030	2035	2025	2030	2035
PROFIT AND LOSSES							
1. TOTAL REVENUES	135,518 €	134,626 €	2,317,848 €	2,316,689 €	167,521 €	159,311 €	151,503 €
2. TOTAL EXPENSES	-78,688 €	-73,751 €	-691,933 €	-662,044 €	-44,225 €	-41,121 €	-38,259 €
3. IBITDA	56,830 €	60,875 €	1,625,914 €	1,654,645 €	123,296 €	118,190 €	113,244 €
4. NET INCOMES	548 €	7,476 €	548,695 €	628,788 €	77,166 €	74,864 €	72,572 €
KPIS							
1. NET PRESENT VALUE	-449,566 €	-330,208 €	-1,678,245 €	-488,159 €	554,375 €	546,407 €	537,588 €
2. INTERNAL RATE OF RETURN	-1.42%	0.34%	4.89%	5.96%	27.61%	23.18%	24.46%
3. WACC	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%
4. LIFETIME	15	15	15	15	15	15	15

Table 72. UC2, UC3 and UC4 results

BUSINESS MODELS	UC5	Tallinn	SF 200 kW	UC6	Zaragoza	25 kW	UC7 Zaragoza	OWPT 50 kW
INCITEV	UC5. 1 Charger 200 kW			UC6. 1 Charger 25 kW for EV and two wheels			UC7. 1 Charger 50 kW 0WPT	
Years described in the Deliverable in detail	2025	2030	2035	2025	2030	2035	2030	2035
PROFIT AND LOSSES								
1. TOTAL REVENUES	80,895 €	84,671 €	70,496 €	37,447 €	35,612 €	33,867 €	32,672 €	32,624 €
2. TOTAL EXPENSES	-32,535 €	-29,797 €	-25,993 €	-20,941 €	-21,219 €	-19,096 €	-17,860 €	-16,329 €
3. IBITDA	48,360 €	54,875 €	44,503 €	16,506 €	14,393 €	14,771 €	14,812 €	16,295 €
4. NET INCOMES	21,430 €	31,918 €	25,464 €	7,220 €	5,979 €	7,143 €	6,337 €	8,314 €
KPIS								
1. NET PRESENT VALUE	55,427 €	131,927 €	76,935 €	-32,595 €	1,250 €	-11,259 €	43,276	73,915
2. INTERNAL RATE OF RETURN	9.32%	17.74%	14.80%	5.99%	6.65%	9.03%	12.25%	17.74%
3. WACC	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%
4. LIFETIME	15	15	15	15	15	15	15	15

Table 73. UC5, UC6 and UC7 results

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12 ANNEXES

Shared Excel Sheet

Excel sheet. UC2. 1-E-Trench 30 kW, 500 m

Excel sheet. UC3. 1 E-Corridor 90 kW power transfer, 25 km

Excel sheet. UC4. 1 Charger 150 kW and 2 chargers 3.6 kW

Excel sheet. UC5. 1 Charger 200 kW

Excel sheet. UC6. 1 Charger 25 kW for EV and two wheels

Excel sheet. UC7. 1 Charger 50 kW OWPT

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