CoSaR

The **Co**nvenient, **Sa**fe and **R**eliable speed E-bike

Application for SME Instruments Phase 1 funding

Participant Number	Organisation Name	Country
904345745	IntuEdrive	Belgium

Executive Summary

E-bikes/pedelecs: electric bicycles with a maximum speed of 25 km/h
Speed E-bikes/speed pedelecs: electric bicycles with a maximum speed of 45 km/h

E-bikes are considered a major player in the transition towards more sustainable mobility: ecological, healthy and compact. But making bicycles faster also increases the risk of accidents and might endanger other road users. This observation has led European legislators to limit E-bikes to 25 km/h. An intense debate arose: this speed limit enormously lowers the potential of E-bikes to serve as commuter vehicles, replacing cars and decreasing pollution and traffic congestions. There is a strong will among policy makers to ease the speed E-bike regulations, but current speed E-bikes simply cannot meet the safety concerns that gave rise to the regulations in the first place.

IntuEdrive (iEd) innovates with its dual motor e-CVT system for E-bikes. It integrates automatic gearing and completely electric braking. The system **reduces the bicycle's stopping distance by more than 60%!** Integrating the system in a stiff frame with smaller wheels and bigger tires, **intuEdrive created CoSaR: the Convenient, Safe and Reliable speed E-bike.** Meeting customers' and policy makers' safety concerns, **CoSaR allows less stringent regulations on speed E-bikes. It provides an alternative to the car for longer distances and a 40% travel time reduction for E-bike commuters.**

CoSaR broadens its market from the current speed E-bike audience towards all customers that use their E-bike for commuting. This was a market of 0,5 million in 2018 in the EU and is expected to grow further at a rate of 15% over the next years. Speed E-bike sales are estimated to reach 1,25 million in 2025. **If speed E-bikes really make a breakthrough, one speed E-bike for every two cars is estimated by 2030, meaning 7,5 million in sales!**

CoSaR pre-sales will be launched in April 2019. As of January 2020, CoSaR is available through dealers in Belgium. 2021 will see CoSaR introduced in the Netherlands and Switzerland. Preparation for this is the subject of this Phase 1 project. The German market awaits for 2022.

With CoSaR, **intuEdrive aims at achieving a market share of 20% of premium E-bikes** (100.000 in 2025). By also selling the intuEdrive e-CVT system to other manufacturers as from 2024, the target is equipping 20% of all speed E-bikes sold in 2025 (250.000) with the system.

Revenue is calculated to go from 3.5 million in 2020 to 35 million in 2022, along with a growth to 21 FTE's in 2023. Beside that, a European company takes the technological lead in the E-bike sector, that is growing worldwide.

1. Excellence

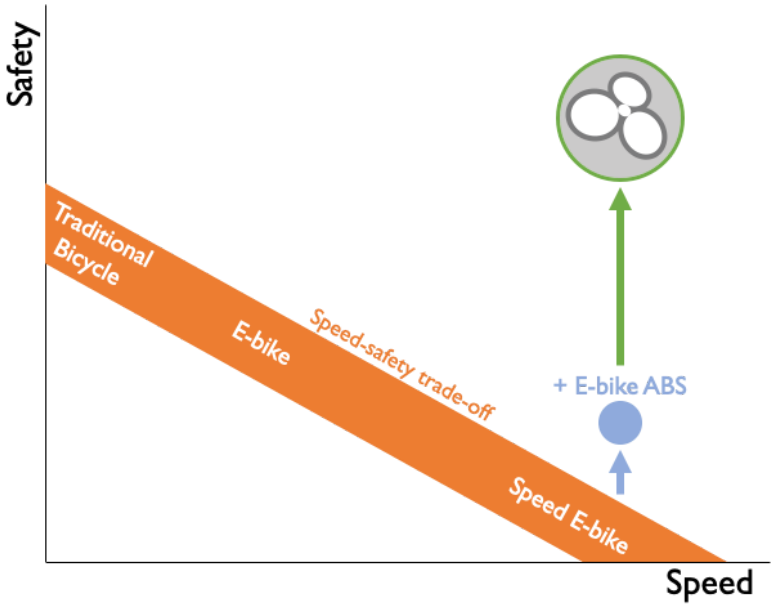
Challenge and solution

E-bikes have increased the potential of bicycles enormously. Electrification has made cycling faster, effortless and allows for more cargo to be transported. **E-bikes are a huge success** and many people looking for mobility alternatives turn to them. The downside of this evolution however, is that **with higher speed, comes higher risk**.

Can you recognize the E-bike? Is it the battery that gave it away?

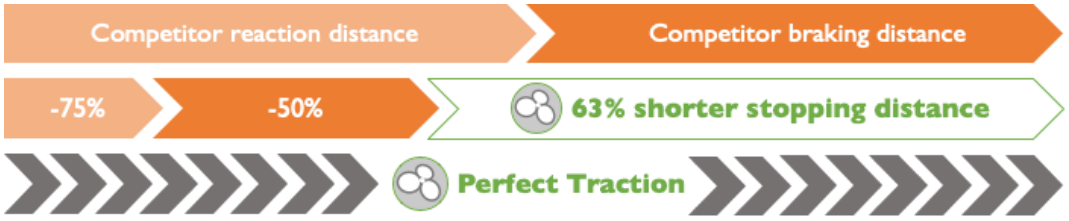
Early electric bicycles were cheap bicycles with an Asian-built motor attached to them. Nonetheless, they quickly became a success and attracted more respectable manufacturers. Automotive suppliers like Bosch started building E-bike components. Quality and refinement improved considerably, but the original bicycle technology was never questioned: manual gears, mechanical brakes and a lightweight bicycle frame to mount everything to. **Speed E-bikes still look exactly like normal bicycles, even though they travel more than twice as fast**. It is as if we still build cars like horse carriages!

The use of **bicycle technology** introduces what we call the **"speed-safety trade-off"**: more speed means less safety[1]. This trade-off has hampered the growth of the speed E-bike market. Thus far, only Bosch has managed to deviate from the speed-safety trade-off by downsizing a motorcycle system into E-bike Anti-lock Braking System (ABS). This however remains an add-on to further unaltered bicycle technology, meaning its functionality is limited[2] and only aids the cyclist in straight line braking. **To really break through the bicycle speed-safety trade-off**, bicycle technology, even with numerous add-ons, is not enough and **a holistic approach to building E-bikes is needed**.



[1] Stability and braking distance are negatively affected by higher speeds.
[2] "The system reaches its limitations in slippery conditions and may increase the braking distance unexpectedly", https://ebike-mtb.com/en/bosch-ebike-abs-review/

IntuEdrive (iEd) innovates with its dual motor e-CVT system for E-bikes. It integrates **automatic gearing** and completely **electric braking**. Automatic gearing means the cyclist no longer has to bother about shifting gears so that he or she can fully concentrate on traffic (other speed E-bikes require constant shifting). This results in shorter reaction times and better anticipation. The integrated electric braking system minimizes the braking distance and avoids slipping. That means **twice as much room to avoid a collision!**



Approach

In bicycle technology, braking and driving systems are never combined and unintegrated. Both use mechanical solutions: chains, brake pads, levers and pedals.
With the rise of electric cars the idea of combining the driving and the braking function in the accelerator pedal came up (one-pedal driving[3]). This is done without extra parts by simply programming the motor in a different way: software! In cars, electric braking can only be done partially because they are too heavy and fast and mechanical brakes are still needed in an emergency. In bicycles on the other hand, the electric motors are strong enough to stop the bicycle completely because they are light and slow[4]. IntuEdrive uses two motors, one for each wheel, and programs them to both drive and brake the bicycle. Just like in an electric car, the cyclist can use the pedals to do both: no need for hand brakes! The use of software makes the system very flexible: extra (active safety) functions can be added by updating the software without adding extra components. That is especially interesting in bicycles, where mounting space is limited.
Just like electric cars, intuEdrive's e-CVT system has a low centre of gravity, making the bicycle more stable. This compensates the slightly higher weight. The iEd system is also two-wheel drive (front and rear) for more stability and traction.
Going yet a step further, intuEdrive builds its e-CVT system into a dedicated speed E-bike: CoSaR, the Convenient, Safe and Reliable speed E-bike. Using a stiff frame and smaller wheels with bigger tires for better traction and stability, CoSaR exploits the full potential of the iEd e-CVT system. Just like a car, CoSaR is developed as a complete, integrated concept rather than as a bicycle with a motor.



[3] https://www.youtube.com/watch?v=577GaCWVpj0
[4] The ability to do electric braking can be indicated by the kinetic energy to weight ratio, which is in fact the maximum speed squared. If this ratio is too high, electric braking is not possible. For cars, this ratio is over 1000 (m/s)^2. For bicycles it is only 50. A ratio smaller than 200 means the vehicle can do full-electric braking.

CoSaR is currently at TRL 9, extensively tested in winter conditions and long distance tests, showing its outstanding performance. Feedback from customers and bicycle dealers has been very positive. CoSaR pre-sales will be launched in April 2019, for delivery in September 2019. Production preparation is underway and CoSaR will go through homologation in May-Aug 2019 (collaboration with TUV Rheinland). As of January 2020, CoSaR will be available through bicycle dealerships in Belgium.

IntuEdrive's technology has the highest customer benefits and market potential in speed E-bikes. Deploying first in those countries that have favorable speed E-bike markets and gathering accident statistics in collaboration with insurance companies, intuEdrive will create new markets for its speed E-bike by showing CoSaR's excellent safety. A 25 km/h version will also be introduced to create market presence in that segment. Rigorous testing, a strong production chain and quality management system will guarantee product performance from the very first day.

In this Phase 1 feasibility study, intuEdrive will further investigate market entry in the Netherlands and Switzerland in 2021: local customer profile, regulatory framework and dealer network. All stakeholders will be contacted: dealers, authorities, insurance and leasing companies. This will help intuEdrive fully understand the market size, and its target customer: the commuter. Germany is the next step on the commercialisation roadmap, in 2022. Market introduction in Germany will be part of SME Instrument phase 2.

2. Impact

Entering the market

Customer needs

E-bikes are considered a major player in the transition towards more sustainable mobility: ecological, healthy and compact. But making bicycles faster also increases the risk of accidents and might endanger other road users. This observation has led European legislators to limit E-bikes to 25 km/h, to be allowed on bicycle lanes. Speed E-bikes are classified as mopeds[5] and are *condemned* to the main road. An intense debate[6] arose: this speed limit enormously lowers the potential of E-bikes to serve as commuter vehicles, replacing cars and decreasing pollution and traffic congestions. There is a strong will among policy makers to ease the speed E-bike regulations, but current speed E-bikes simply cannot meet the safety concerns that gave rise to the regulations in the first place. As Kevin Mayne from the European Cyclist Federation put it[7]:

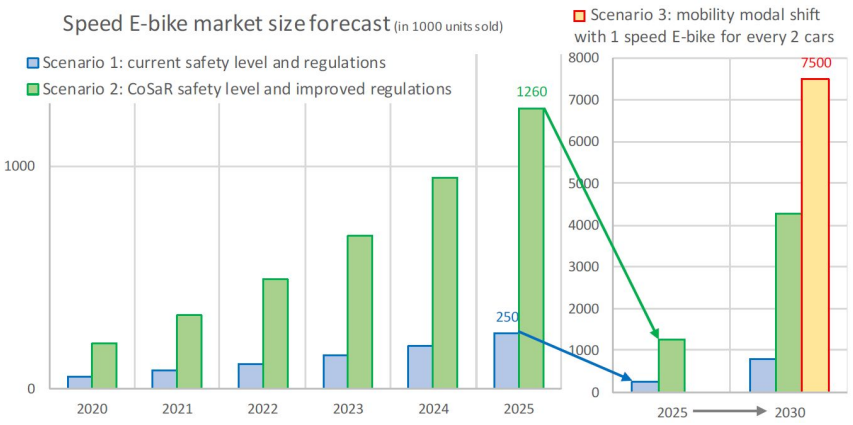
"Yes, they may be a valuable resource moving people to the two wheeled sector but the risks are far from understood and the industry is apparently not prepared for the public backlash if the speed pedelec damages the safe reputation of the bicycle. [...] more research and knowledge sharing could boost the Pedelec business. The Horizon 2020 programme [...] could play an important role in this respect."

Meeting customers' and policy makers' safety concerns, CoSaR takes away the arguments for imposing stringent regulations on speed E-bikes. It provides an alternative to the car for those traveling a distance too long for a 25 km/h E-bike and also means a 40% travel time reduction[8] for E-bike commuters.

[5] L1e-B vehicle category, requiring type approval and license plate.
[6] https://ecf.com/system/files/CeriWoolsgrove_SpeedPedelecDebate.pdf
[7] https://ecf.com/news-and-events/news/first-time-eu-report-recognizes-pedelecs-innovative-transport-solution
[8] 35 km/h average speed compared to 20 km/h for a normal E-bike, numbers based on Strava trip data.

Market size, growth and demand for CoSaR

CoSaR broadens its market from the current speed E-bike audience (a 1-3% niche market in all countries but Switzerland) towards the quarter of buyers that use their E-bike for commuting. This was a **market** of 0,5 million in 2018 in the EU and is expected to grow further at a rate of 15% over the next years[9]. Speed E-bike **sales** are estimated to reach 1,25 million in 2025. If speed E-bikes really make a breakthrough, one speed E-bike for every two cars is estimated by 2030, meaning 7,5 million in sales. If speed E-bikes cannot outgrow the niche market they are today, 0,25 million in sales are expected in 2025.



Sold at the price of a high-end 25 km/h E-bike, CoSaR will appeal to commuters that feel unsafe on other speed E-bikes. This USP of CoSaR is well formulated by Olivier, a premium bicycle dealer in Leuven. After trying out CoSaR for an hour, he said[10]:

"I've always believed in the potential of speed E-bikes, but never found them good enough to sell. After trying CoSaR, I have to say I feel very safe on this E-bike. It feels really stable and the electric braking gives me the confidence that I have control over my speed. I would happily promote this E-bike to my customers"

Other dealers have also received CoSaR with great enthusiasm. Wildiers Bicycles, owner of 3 large shops and selling more than 2000 E-bikes per year, wrote a letter of intent[11] stating they will buy a pilot version CoSaR in September 2019 and that they will take up CoSaR in their stores as of January 2020. Chamizo in Mechelen, selling 500 speed E-bikes per year, testified on video[12] about CoSaR's potential. KBC bicycle lease[13], offering bicycle leasing contracts (currently 7300 bicycles), were very enthusiastic to take CoSaR up in their product portfolio. In a long email following the demonstration, they expressed their respect for intuEdrive's vision and technical excellence:

"Congratulations on your fantastic product and many thanks for letting us experience it!"
"Your product is absolutely lease-proof*, because of its build quality and safety focus."*

With CoSaR, intuEdrive aims at achieving a market share of 20% of premium E-bikes (100.000 in 2025). By also selling the intuEdrive e-CVT system to other manufacturers as from 2024, the target is equipping 20% of all speed E-bikes sold in 2025 (250.000) with the system.

5 CoSaRs have been sold and paid already by early adopters, before any official communication.

Market conditions

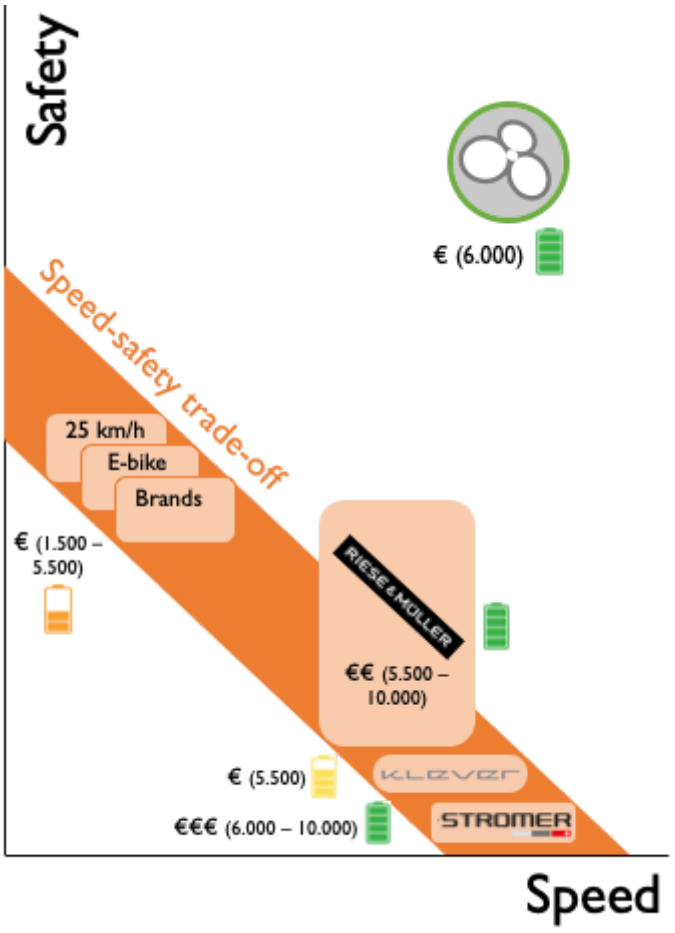
Several external market conditions that are favorable for speed E-bikes:

- Speed E-bike regulations: permission to use bicycle lanes, ...
- Good and/or improving cycling infrastructure
- Traffic congestion

[9] https://www.bike-eu.com/sales-trends/nieuws/2018/03/e-bike-sales-soared-in-eus-main-markets-10133378
[10] https://drive.google.com/open?id=1w4jGfnu9htRlLVawQ7wj_f8GEVJ4q3L_
[11] https://drive.google.com/open?id=1w4jGfnu9htRlLVawQ7wj_f8GEVJ4q3L_
[12] https://drive.google.com/open?id=1w4jGfnu9htRlLVawQ7wj_f8GEVJ4q3L_
[13] https://www.kbc.be/corporate/en/product/financing/leasing/bicycle-leasing.html

- Tax incentives for bicycles
- Many relatively short commutes (< 25 km one way) with only one person in the car

Almost all EU countries suffer traffic congestions and have a large share of short commutes. Cycling infrastructure is improving everywhere in Europe, with many "bicycle highways" in Germany, the Netherlands and Belgium[14]. Regulations and taxes therefore remain the two decisive factors. Belgium, Switzerland, Denmark and – a little less so – the Netherlands have supple regulation on speed E-bikes. Belgium also has strong tax incentives[15]. The situation in the Netherlands and Switzerland will be investigated in this feasibility study. We expect all countries to ease their policies towards speed E-bikes when it becomes clear that they are no longer a safety risk. It is obvious from the numerous changes in speed E-bike regulation in the last couple of years that these policies are not yet 'carved in stone'.



Competition

E-bikes currently on the market use bicycle technology – manual gears, mechanical brakes, large wheels with relatively thin tires – with an electric motor on the pedals (mid-drive), rear wheel or front wheel. Depending on the limitation of the motor, the E-bike can go 25 km/h or 45 km/h. Mid-drive systems, primarily from Bosch, are the most common in Europe and are used by many bicycle manufacturers including Riese&Müller (R&M), both for 25 and 45 km/h E-bikes. Rear wheel hub motors are used by Stromer and Klever. All brands use powerful hydraulic disk brakes. Safety of these systems (braking distance, tip-over and wheel lock) primarily depends on the tires and whether E-bike ABS is installed.

More interesting than a comparison of today is the potential of competitors to come up with new technology. Both Klever and Stromer can theoretically implement electric braking in their systems, but not enough for a full stop. They cannot offer extra safety with it. Bosch, having a reputation in safety systems, is expected to introduce new features. But it is required to develop new hardware for every new function (typically 2 years), giving it a competitive disadvantage over intuEdrive's software-based solution.

Barriers to entry

Production: Working together with production partners, intuEdrive limits investments while keeping maximum flexibility. To guarantee quality in each step of its production process, IntuEdrive developed its own ISO 9001 quality management system (QMS, to be certified Q2 of 2019). Production capacity will be ready to produce 100 CoSaRs by September 2019 and will be in full swing for the 2020 market introduction.

[14] Flanders targets 2700 km of bicycle highway
[15] Bicycle allowance in Belgium 0.22EUR/km

Dealer network: Through its contacts at KBC bicycle lease, intuEdrive has direct access to KBC's dealer network and product portfolio. Convincing dealers to take CoSaR up in their sales gamma proves no problem so far. Bicycle dealers have no brand exclusivity, making it easier for a new player to enter the market.

Business model

Value chain

Software is at the core of CoSaR USP. It took intuEdrive 3 years to develop this software together with university partners. The development roadmap gives intuEdrive a competitive edge in the years to come. The COGS can be kept low, due to the simple and standard parts to build the iEd e-CVT. Non-standard designs are all owned by intuEdrive, so intuEdrive is not dependent on a single supplier and cost can be more easily reduced.

Electronics, frame and rear hub are produced by production partners Elemaster[16], Pacific Cycles[17] and Sunrace[18]. The parts are ordered based on an MRP[19] rolling forecast approach and shipped to the assembly facility in Genk. CoSaR is designed so that all long lead time components are the same for all bicycle versions. Different options and versions are realized in the final assembly stage of production.

Dealers order CoSaR via an online configurator and receive the order within three weeks. Bicycle dealers are an important stakeholder in our value chain, because of their proximity to customers and influence on their choices. 85% of buyers state they follow the dealers' advice on what bicycle to buy. Also for after sales service, the dealer is an important asset. KBC bicycle lease strictly buys from bicycle dealers and never directly from the manufacturer. IntuEdrive has

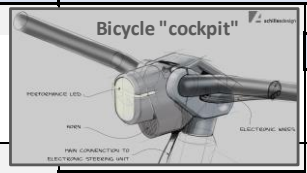
LOI's and testimonials from large dealers of KBC's network in Belgium following a demonstration of CoSaR. The same approach will be used in this Phase 1 project for dealer contacts in the Netherlands and Switzerland.

Scaling

Because intuEdrive works with large production partners, investment in factories is avoided and production capacity is not a bottleneck for fast scaling. The assembly facility in Genk can quickly scale to a capacity of 20.000 units per year, having a highly flexible workforce and plenty of room. Software is off course easily scalable. Dealer network is readily expanded if needed. Where interacting directly with dealers is inefficient because they are too wide-spread, intuEdrive will approach local distributors (e.g. Hartje[20] in Germany, the Netherlands and Belgium).

[16] https://www.elemaster.com
[17] http://www.pacific-cycles.com
[18] http://www.sunrace.com
[19] Material requirement planning
[20] https://www.hartje.de/en/bicycle/bicycle-brands/

ROADMAPS PRODUCT	2019 Q1 Q2 Q3 Q4	2020 Q1 Q2 Q3 Q4	2021 Q1 Q2 Q3 Q4	2022 Q1 Q2 Q3 Q4	2023 Q1 Q2 Q3 Q4	2024 Q1 Q2 Q3 Q4	2025 Q1 Q2 Q3 Q4
	CoSaR v1.0	CoSaR v1.1 - 45kph	CoSaR v1.1 - 45kph	CoSaR v1.1 - 45kph Cost reduction	CoSaR v1.2 - 45/25kph iEd e-CVT v2	CoSaR v1.2 - 45/25kph	CoSaR v1.2 - 45/25kph
	100 bicycles Direct sales by intuEdrive to FFF (crowdfunding) List price 6000€ w/ VAT COGS 2500€ No dealer margin HARDWARE 45kph "Sport" & "Comfort" Front cargo SOFTWARE Free software updates	1000 bicycles **Belgium dealer** (intuEdrive → dealer) List price 6000€ COGS **2000€** **30% dealer margin** HARDWARE ← SOFTWARE ← + **Safety 1.0**	2500 bicycles ← + **Netherlands + Swiss dealer** List price 6000€ COGS **1900€** HARDWARE ← + **Bicycle "trunk"** SOFTWARE ← + **Safety 2.0**	6000 bicycles ← + **German dealer** List price 6500€ COGS **1700€** HARDWARE ← + **Bicycle "cockpit"** SOFTWARE ← + **Safety 3.0**	18000 bicycles ← + **EU distributor** List price 6500/5500€ COGS **1500/1300€** HARDWARE ← + **iEd e-CVT v2** SOFTWARE **Software service model**	30000 bicycles ← + extend **EU network** List price 6000/5000€ COGS **1400/1200€** SOFTWARE ← + **Safety 3.0**	40000 bicycles ← + **US? Asia?** List price 6000/5000€ COGS **1300/1100€**
			CoSaR v1.1 - 25kph Small battery	CoSaR v1.1 - 25kph	CoSaR v2 ALL NEW	CoSaR v2	CoSaR v2
			500 bicycles List price 5500€ COGS **1700€**	4000 bicycles List price 5500€ COGS **1500€**	2000 bicycles List price ??00€ COGS ??00€ **Specifications??**	20000 bicycles iEd e-CVT v2 **Tier 1 Supplier**	60000 bicycles iEd e-CVT v2
MARKETING							
PRESS						Press launch (bicycle & *automotive* press) Press bike for magazine/YouTube testing	
SHOWS							
COMPETITIONS					EU strategy TBC		
PROMOTION	Website Webshop						
DEVELOPMENT							
SOFTWARE							
SAFETY	**Safety 1.0 (Straight line)**	**Safety 2.0 (Low speed corner safety)**		**Safety 3.0 (High speed corner safety)**			
DRIVE UNIT							
iEd e-CVT v1			**Cost reduction**				
ALL NEW iEd e-CVT v2				**Hardware development**			
SYSTEM SUPPLIER					**Integration by other OEM**		
BICYCLE							
CARGO		**Bicycle "trunk"**					
HMI (HUMAN MACHINE INTERFACE)			**Bicycle "cockpit"**				
ALL NEW CoSaR v2			**Market research**	**Hardware development**			
COMPETITOR							
BICYCLE OEM	Stromer & Klever						
Rear hub motor			**Weak electric braking by pedal input?**				
AUTOMOTIVE SUPPLIER							
Integrated motor & gears	**Continental Revolution, Oechsler DriveMatic,...**						
Active safety	**ABS brakes: Bosch, ZF (BFO), Continental**			**Bicycle Stability Control?: Bosch, Continental? (requires new hardware!)**			
AUTOMOTIVE OEM							
Integrated E-bike devpt.	**Currently no innovative product development (only "greenwashing", marketing) but Ford applied over 50 bicycle patents in the last 10 years (!!!)**						



Further road map to be defined based on future personal mobility trends:
- (speed) E-bike sharing?
- speed increase?
  → aerodynamic bodywork?
- bicycle to vehicle communication?
  → human powered vehicle on the road?
- *autonomous bicycle...* 😊

Financing

IntuEdrive is owned by founder Tomas Keppens and co-founder Jorrit Heidbuchel, each having a 50% share. CoSaR prototype development was done with founder capital (100.000 EUR), FFF loans (75.000 EUR) and an innovation grant from the Flemish government[21] (170.000 EUR) for which a follow-up application has been filed in January 2019 (250.000 EUR) to co-finance further development of the iEd e-CVT. Capital for production of the first CoSaR pilot series (100 units) will be raised by selling all of these bikes in the spring of 2019 (500.000 EUR). Official launch of these sales will be April 2019, delivery is planned for September 2019. Thus far already 5 have been sold before the official launch. A capital round (1.000.000 EUR) for November 2019 is being prepared that will leverage on this first milestone of 100 units sold and produced. The goal of this capital round is to raise capital for commercialisation in Belgium in 2020. IntuEdrive's founders are assisted by LRD[22] in preparing this capital round. In parallel, this phase 1 project will prepare a commercialisation plan for market entry in the Netherlands and Switzerland in 2021. A Phase 2 project will be applied for in early 2020, to roll out the business plan resulting from this phase 1 project. Market entry in Germany in 2022 will also be part of that SME Instruments phase 2 project.

IPR and legal framework

Homologation and certification: Type approval for CoSaR will start in April 2019 in collaboration with TüV Rheinland, with the current CoSaR prototypes. Minor changes to the design have already been applied based on the feedback from TüV . Elemaster, our electronics supplier, is certified by TüV for doing EMC tests, making the type approval tests more efficient. IntuEdrive will be certified as a manufacturer with ISO 9001 QMS in Q2.

IPR and knowhow: Key knowhow is in the intuEdrive e-CVT system layout (protected by patent WO2018113998[23]), electronics design and in the software that controls the system. Without it, the layout in itself is useless. None of the software is shared outside the company. A strict classification policy is upheld and all employees are bound by an NDA. Wherever possible, intuEdrive also protects software features in a patent[24]. Electronics are manufactured in Europe by Elemaster, a respectable company, bound by an NDA.

FTO: Extensive FTO studies have been performed on the system layout and working principle. Based on the same working principle, some other patents have been granted, but none of these combine the driving function and the braking function like intuEdrive does.

[21] Innovation project subsidy by VLAIO (vlaio.be), project number **HBC.2017.0978**
[22] Leuven Research and Development (https://lrd.kuleuven.be/en), see also company section
[23] By name of Founder Tomas Keppens and transferred to IntuEdrive.
[24] Patent application EP 18 18 0607, unpublished, on the take-off control of the bicycle.

ROADMAPS PRODUCT	2019	2020	2021	2022	2023
PRODUCTION & SERVICE FTE's	1.7	3.8	5.1	7.1	7.8
	CoSaR v1.0	CoSaR v1.1 BE	CoSaR v1.1 BE+NL+CH	CoSaR v1.1 BE+NL+CH+DE	CoSaR v1.2 EU
					CoSaR v2
MARKETING					
SALES & MARKETING FTE's	1.3	3.4	4.8	5.9	8.7
PRESS					
SHOWS					TBC
PROMOTION					
DEVELOPMENT					
DEVELOPMENT FTE's	1.9	2.6	3.6	4.5	4.5
Revenue (€)	**500,000**	**3,471,000**	**10,269,000**	**35,289,000**	
COGS (€) (manufacturing, shipping, direct labour)	250,000	2,000,000	5,600,000	16,200,000	
Total Variable Costs (€)	**250,000**	**2,000,000**	**5,600,000**	**16,200,000**	
Gross Profit (€)	**250,000**	**1,471,000**	**4,669,000**	**19,089,000**	
Personnel w/o development FTE's (€)	226,889	535,704	717,602	915,678	
Marketing (€)	50,000	100,000	150,000	200,000	
Rent (€)	0	20,000	50,000	80,000	
Utilities (€)	45,378	107,141	143,520	183,136	
Legal Consulting and IP Protection (€)	50,000	80,000	100,000	100,000	
Accounting (€)	5,000	10,000	20,000	30,000	
R&D Project w/ development FTE's (€)	299,456	322,039	506,261	450,877	
Indirect Costs (€)	105,269	171,549	244,772	273,311	
Total Fixed Costs (€)	**781,992**	**1,346,433**	**1,932,155**	**2,233,002**	
EBITDA (€)	**-531,992**	**124,567**	**2,736,845**	**16,855,998**	
D&A (€)	16,667	36,667	53,333	70,000	
EBIT (€)	**-548,658**	**87,900**	**2,683,511**	**16,785,998**	
Interest (€)	5,000	40,000	112,000	324,000	
EBT (€)	**-553,658**	**47,900**	**2,571,511**	**16,461,998**	
Tax (€)	0	11,975	504,463	4,115,500	
Net Profit (€)	**-553,658**	**35,925**	**2,067,048**	**12,346,499**	
Cash Flow (€)	**-553,658**	**35,925**	**2,067,048**	**12,346,499**	

3. Implementation

Team

Founder Tomas Keppens (CEO) started his career at Siemens LMS as a software developer and later moved to Toyota where he worked for 17 years. He was the noise and vibration department manager (10 people) before he resigned to devote himself entirely to the intuEdrive project that had him intrigued since 2010. Jo Broers (COO) has worked as a plant manager in the electronics sector almost his entire career and ran the production plant for JLG[25] telehandlers in Maasmechelen (200 employees) before joining intuEdrive. His extensive experience in production and quality management proves an invaluable asset to the company. Jorrit Heidbuchel (CTO) developed the intuEdrive e-CVT system together with Tomas Keppens when he was still at university. He graduated as a mechanical engineer on the control software for the system and co-founded intuEdrive directly after that. With two more engineers working on the project complemented with university[26] and production partner knowhow, intuEdrive has a strong technical and operational team.

Strong marketing and sales competences are still missing in the team. Currently these are insourced through an advisory team of business angels and investors. IntuEdrive is on the lookout for a sales and marketing manager to start in the summer of 2019 for preparation of market introduction in 2020. For the

[25] https://www.jlg.com/en/region-language-selector?Cookie=language

[26] IntuEdrive and KUL, University of Leuven, co-develop multibody software for virtual bicycle tests.

introduction in the Netherlands and Switzerland, extra help from the SME Instruments phase 1 coaching will be called upon.

Work plan

Work Package Title	Feasibility Study
Objectives	Develop a business plan to introduce CoSaR in the Netherlands and Switzerland: choice of dealer network, product adaptation for local market, regulatory aspects. Rally support from strategic dealer network and local stakeholders (government, leasing and insurance companies).
Description of work	1. Map geographical distribution of dealers and sales volume of the current (speed) E-bike market. If possible, data is acquired from local sector organisations. Otherwise intuEdrive will make its own estimate based on dealer accounts. Special focus for customers in a business context, e.g. leasing bicycles. 2. Analyse market profile by means of local E-bike magazines, consumer organisations and dealer interviews and adapt CoSaR accordingly. 3. Visit strategically important dealers and leasing companies based on the analysis in point 1 and present CoSaR. Ask for their feedback, estimated retail price and their sales projection if they would start selling the product. Figure out what the local dealers' revenue model is, margin on sales or service fees, and how they want to be supported by intuEdrive for after sales service. 4. Prepare roll-out of strategic dealer landscape by establishing a business relationship with good local dealers, gathering LOI's and dealership contracts to substantiate fundraising. All tasks are performed by intuEdrive
Deliverable	Feasibility report, including a business plan, for commercialization in the Netherlands and Switzerland. Formal support from local dealers to substantiate market potential for fundraising. Month of delivery: October 2019

Resources

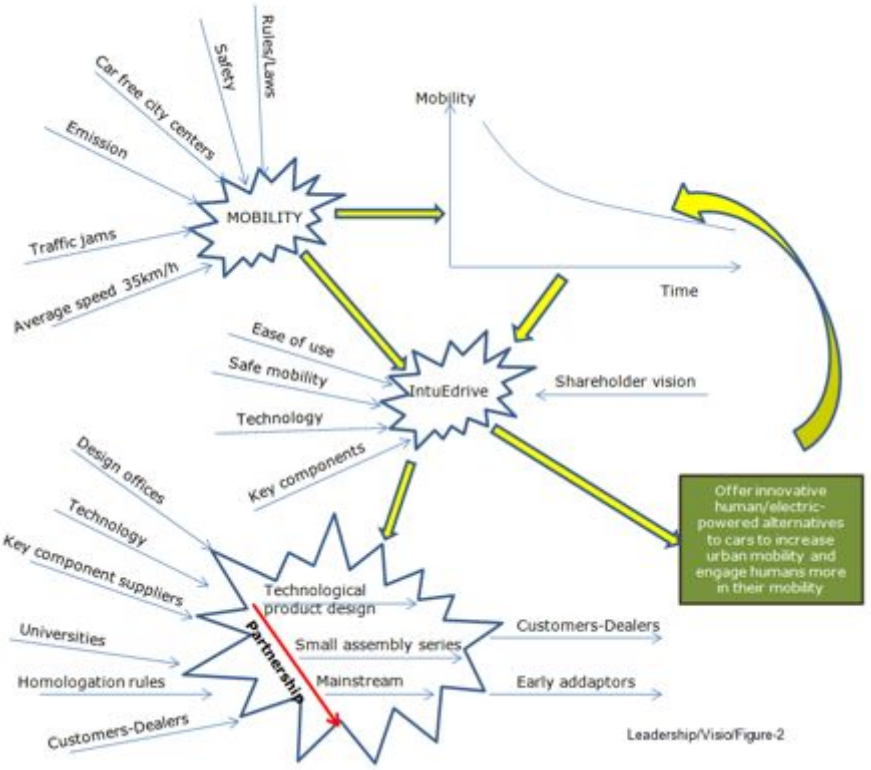
	Costs of the feasibility study/ Direct and indirect costs of the action	Total costs	Reimbursement rate %	Maximum EU contribution	Maximum grant amount
Form of costs	Lump sum				
	50 000	71 429	70%	50 000	50 000

4. Company

IntuEdrive

Context of the organisation

The changing conditions of today's mobility inspire IntuEdrive to propose solutions to restore mobility.



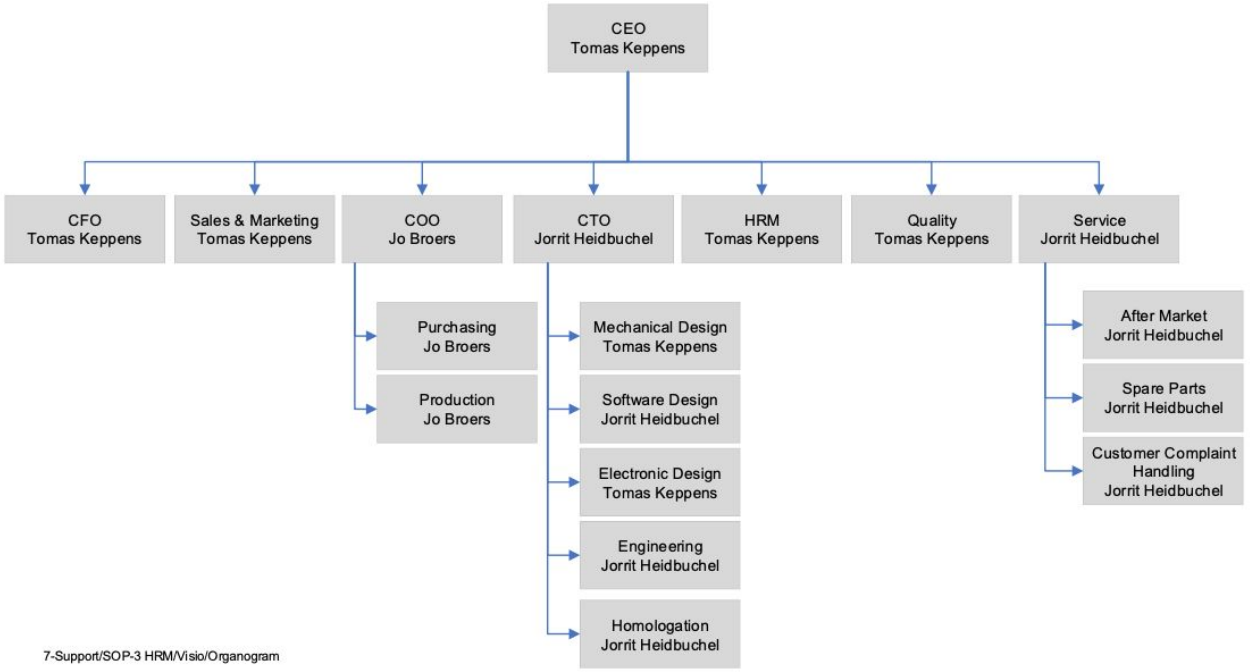
- Owned by Tomas Keppens and Jorrit Heidbuchel, each having a 50% share in the company.
- Broad technical team of engineers and product designers (mechanics, electronics, software, production) complemented with a strong network of partners:
    - **KULeuven PMA** (https://www.mech.kuleuven.be/en/pma). IntuEdrive co-develops multibody software for bicycle computer simulations. This co-development gives the company a strong connection with the university, able to tap into the technical resources and stay keep up to date of the latest technological trends. The intuEdrive e-CVT project has been developed in close collaboration with KULeuven PMA from the start in 2010. KULeuven and IntuEdrive have an agreement that all bicycle-related technology is owned by intuEdrive whereas all derived technology is available to the university. This long-lasting partnership between intuEdrive's founders and the university also allows intuEdrive to work with LRD (see below).
    - **PIAK electronic design** (piak.nl). PIAK is a Dutch R&D company specialized in motor control. Working with PIAK, intuEdrive implements top-notch motor control algorithms that do not require motor sensors. This has major reliability benefits.
    - **Elemaster** (https://www.elemaster.com) is an electronics manufacturing multinational with a strong development background and extensive experience in electronics design for cars and trains. They have therefore important expertise for electronics durability in harsh environments. Elemaster is also certified to do EMC testing for type approval, making the

homologation procedure for CoSaR much lighter. IntuEdrive COO Jo Broers ran the Elemaster plant in Romania for a couple of years and has good contacts in the organisation.

- **Topology** (http://www.topology-tech.com/?_lang=en) is a Chinese daughter company of Star Union (http://en.star-union.net) and builds bicycle brakes, displays, buttons, etc. Star Union was an early player in the E-bike market in China and the company currently equips around 10 million bicycles per year with their brakes, handlebars and displays. Topology was created to capture the European market. IntuEdrive's founders came in contact with Leo Liao, Topology CEO, at Eurobike 2018 when looking for a display supplier. He was immediately interested in intuEdrive's technology and made a test ride on an early prototype. After discussing with Star Union's CEO, they offered to start discussions to buy intuEdrive. This offer was declined because intuEdrive is convinced that the speed E-bike potential will not be properly exploited if the technology is in Chinese hands. A strong collaboration with Topology nonetheless came to be. In January, the CEO visited Belgium and had a meal at Tomas Keppens' home for a long discussion on the future of E-bikes. Topology agreed to start development of a "cockpit" – integrated display in the bicycle handlebar – together with intuEdrive and Achilles Design design company (see below)
- **Pacific Cycles and Stijn Deferm** (http://www.pacific-cycles.com; https://stijncycles.wordpress.com). Pacific Cycles is one of Taiwan's oldest bicycle frame manufacturers. They specialize in "out-of-the-ordinary" designs and were immediately convinced when trying out an early CoSaR prototype. Pacific now builds the CoSaR frames. Stijn Deferm is a Belgian who works as Pacific Cycles' chief bicycle designer. He makes many designs for Riese&Müller, a highly respected bicycle brand. IntuEdrive worked with Stijn to develop the CoSaR frame. His extensive experience in small-wheel design made him the perfect person for CoSaR.
- **Achilles Design** (https://www.achilles.be). Achilles is an industrial design bureau that made the initial CoSaR design, before the frame design was handed over to Stijn Deferm for production preparation. Achilles later designed the electronics and battery housing. IntuEdrive, Topology and Achilles Design have started a co-development for a bicycle "cockpit" module that will be introduced in the 2022 CoSaR.

- Sales, marketing and legal knowledge is insourced through an advisory board of business angels and coaches and via a network of commercial partners
  - LRD, Leuven Research and Development (https://lrd.kuleuven.be/en) is a division of the university of Leuven that coaches and assists university spin-offs and SME's in business management, fundraising and legal aspects. IntuEdrive, thanks to its strong connection with KULeuven, is also coached by LRD. LRD is also represented in the Gemma Frisius Fund (GFF, https://lrd.kuleuven.be/en/spinoff/gemma-frisius-fund), a venture capital fund investing in spin-offs and SME's using KULeuven technology. This gives intuEdrive good connections in the investment world.
  - KBC Bank and Insurance (https://www.kbc.be/corporate/en.html?zone=topnav) is a member of Gemma Frisius Fund and a pioneer of bicycle leasing schemes. IntuEdrive has good contacts with both KBC Private Equity (Isabelle Cardinael) and KBC Bicycle Lease (Kristof Huysecom, Tom Vlaminck). IntuEdrive as regular meetings with them. KBC bicycle lease is already committed to taking CoSaR into their product portfolio and intuEdrive has been given access to the company's bicycle dealer network. Because KBC is also an insurance company, accident statistics for CoSaR will be available through them, strengthening CoSaR's safety claim.
  - Expanding bicycle dealer network
    - http://www.fietsenwildiers.be
    - https://www.chamizo.be

        - https://www.fietsenking.be
        - ...
- The management team is well embedded in Europe's technological landscape, having the experience and contacts from over 20 years in automotive industry (Tomas Keppens) and 40 years in various production environments (Jo Broers) as well as good contacts in the IT sector.
- IntuEdrive's core team consists of the two founders, ir. Tomas Keppens and ir. Jorrit Heidbuchel, further strengthened by ing. Jo Broers and ir. Menno Vanfrachem.
    - Ir. Tomas Keppens (50% shareholder) (°1971)
        - 2017 – present: Founder and CEO of intuEdrive
        - 2015 – 2018: Technical manager Model Based Development at Toyota Motor Europe (working half-time on CoSaR, half-time in TME)
        - 2010 – 2015: Department manager Noise and Vibration at TME
        - 2005 – 2006: Traineeship in Toyota Motor Corporation, Nagoya
        - 2001 – 2010: Noise and Vibration engineer/manager at TME
        - 1995 – 2001: Noise and Vibration engineer at Siemens SISW (back then LMS)
        - 1995: Master in Mechanical Engineering, option Mechatronics, KU Leuven
    - Ir. Jorrit Heidbuchel (50% shareholder) (°1993)
        - 2017 – present: Co-founder and CTO of intuEdrive
        - 2017: Master's thesis on building and programming a prototype of what is now the iEd e-CVT, KU Leuven (Magna Cum Laude)
        - 2017: Master in Mechanical Engineering, KU Leuven (Magna Cum Laude)
    - Ing. Jo Broers (COO, no shareholder in intuEdrive) (°1952)
        - 2018 – present: COO of intuEdrive
        - 2013: Plant manager at JLG, telehandlers production
          Overseeing all operational, cost and quality processes
        - 2006: Plant/operations manager in Romania, electronic manufacturing and ISO 9001 introduction, multi-site MRP system introduction (Material Requirements Planning), new factory layout.
        - 2004: VP Operations, Krypton laser measurement system start-up, ISO 9001-2000 introduction
        - 1986: Philips
    - Ir. Menno Vanfrachem (in charge of software development) (°1996)
        - 2018: Master in Computer Science: Mathematical Modelling, KU Leuven (Magna Cum Laude)
        - 2016: Bachelor in Computer Science and Electrical Engineering, KU Leuven



- Infrastructure, tools and equipment:
    - Registered office in Kampenhout, head office in Leuven, Belgium. Half an hour drive from Brussels. The current office has room for 4, plans to move to new offices in the city of Leuven.
    - 60 m^2 mechanical workshop
    - Access to all relevant software tools: CAD software, Matlab/Simulink engineering simulation software, ERP package.

5. Ethics and Security

Ethics

The project will make use of existing literature, documentation and data that is publicly or commercially available (statistics from departments of transportation and transport sector organizations). Apart from that, experts will be consulted for their insights in the domains that are being covered in the project tasks. Large scale market studies with questionnaires are beyond the scope of this project. However, small scale qualitative research may be done in customer target groups and with bicycle dealers in line with GDPR. Only general conclusions will be drawn from this research and no personal data will be stored or processed for its purpose.

Security

None of the project's activities will raise any security issues.

There will be no "EU-classified information" involved.