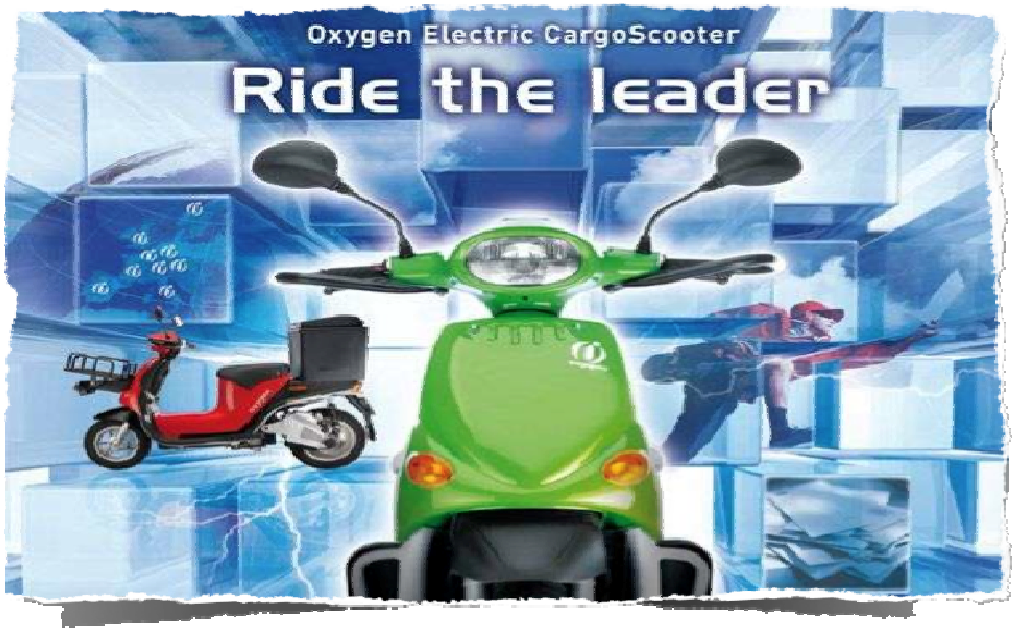
CargoScooter Drive Train



Founded in 2000, Oxygen is the world leader in the development and manufacturing of electric scooters for the delivery business

2000 2002

Oxygen launched first generation scooter for the consumer market (**Lead-Acid Batteries**)

2004

First to introduce the fleet-model: the "PostScooter" with Nickel-Zinc technology

2006

Oxygen launches the **CargoScooter** with **Saphion Lithium-Ion** battery system

2008

Oxygen implements technology with **Electric brake, a regenerative brake system and the advanced speed control**

TODAY

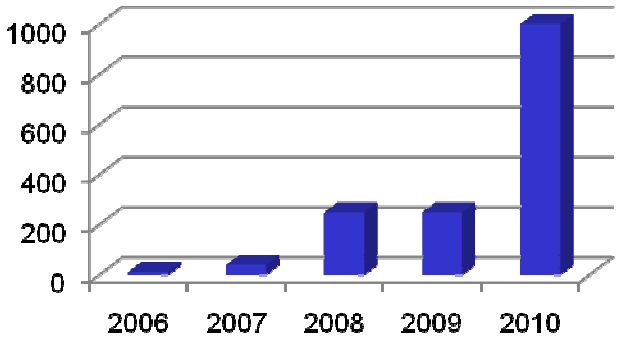
Oxygen is the official provider of the **largest zero emission postal delivery fleet in the world**

Oxygen has ten years experience in LEV's

European professional companies rely on the CargoScooters

SWISS POST

Swiss Post n° scooter

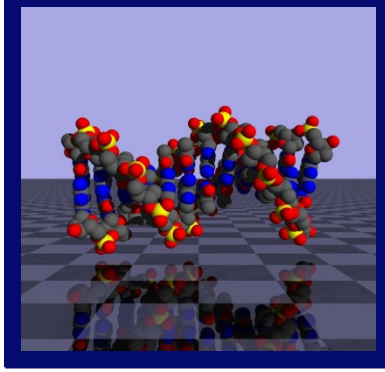


User needs

Electric scooter as a job partner

- Reliability
- Safety
- High load capability
- Long life
- Stop and go “proof”
- Easy to park
- Maneuverable
- “Zero” parking constrains
- “Zero” mechanical vibration
- “Zero” maintenance
- “Zero” noise

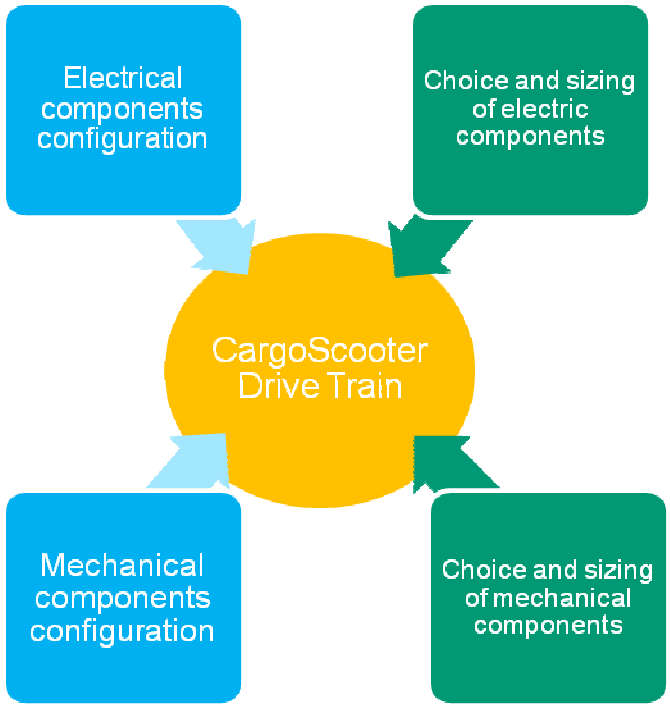
PRODUCT DNA



- Customizable
- Flexible and modular

QFD CargoScooter Drive Train

tech. specification / customer requirement	*customer importance*	few moving part	no fluids	high torque	linear power erogation	maintenance part easy to reach	adjustable performance	parking brake	low COG	reverse mode	settable drive mode	multi voltage	LiFeMgPO4 Battery	mechanical transmission	gear
high reliability	***5***	5	1			1							1		
zero maintenance	***4***	5	3										3		
easy to park	***4***			1	2			5	4						
no parking constrain	***4***		5										1		
high maneuverability	***4***			3	2			1	5	5	4		1		
silent	***4***	3	2												
long life	***3***	5	2			2									
no vibration	***3***	4	1												
high load capability	***5***			5	2			1	4	2			2		5
customizable	***4***						5				5	4	2		
easy to maintain	***3***	4	2			5									
safety	***5***	3	2		3	1	1	3	3	1	3		2		
long range	***3***	4	1		1		2				3		2		
		123	73	41	44	31	31	44	71	35	60	16	59	0	25



- **Mechanical configuration:**
  - •direct drive motor
  - •motor control built in the motor arms
  - •mechanical braking system integrate in the arm
- **Electric configuration:**
  - •multi-voltage control unit
- **Electrochemical configuration:**
  - •modular battery pack system

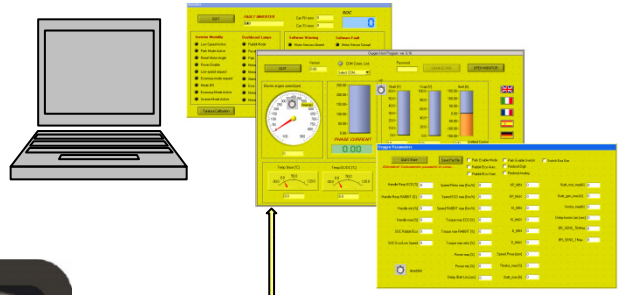
- **Mechanical sizing and component choice**
  - •We used aluminum component
  - •12” wheel
  - •We maximize the arm and control unit case dimensions
- **Electric sizing and component choice:**
  - •brushless motor
- **Electronic sizing and component choice:**
  - •IXYS Trench Gate MOSFET Modules with lower Rds(on) GWM100-01X1-SMD
- **Electrochemical components**
  - •We choose LiFeMgPO4 batteries for long life and safety performance

Drive Train Overview

Oxygen Macro-component Design for
Assembly and to optimize the supply chain

oxygen

CONNECTIVITY
Dedicate SW for:
•Boot loader
•Diagnostic
•Tuning

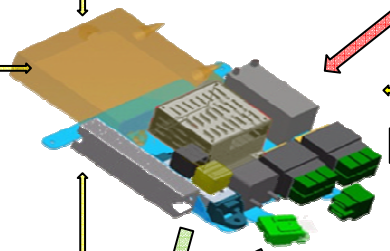


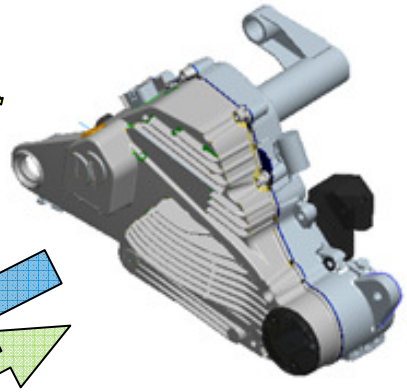
AUXILIARY SYSTEM
•Light
•Horn
•Etc..

TROTTLE
Patent speed control algorithm
1 G working cycles

MULTI VOLTAGE AND MULTY FUNCTIONAL MOTOR CONTROL UNIT
2-stages Drive: Booster+ 3 phase inverter with advance functionality:
•Patent EHC system
•Reverse mode
•Safe drive mode

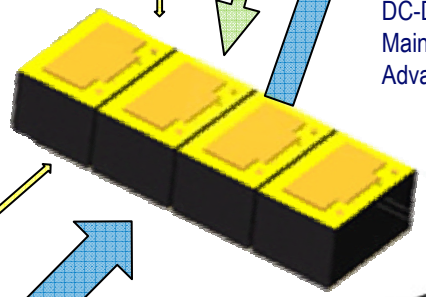
HUMAN INTERFACE
Full graphics
Customizable
Adjustable



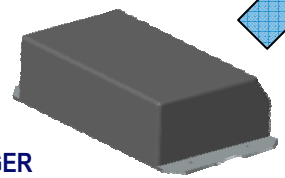


TRAY: main electromechanical components
Auxiliary 12V battery (supply the system if faulty traction batteries)
DC-DC 100W insulated DC/DC Converter
Main power contactor
Advanced BMS

TRACTION BATTERIES
LiFeMgPO4
Modular battery pack:
•24 V 2.6 kWh
•36 V 2.6 kWh
•36 V 3.9 kWh
•48 V 5.2 kWh



BRAKING SYSTEM
Patented regenerative braking system integrate with mechanical disc brake system



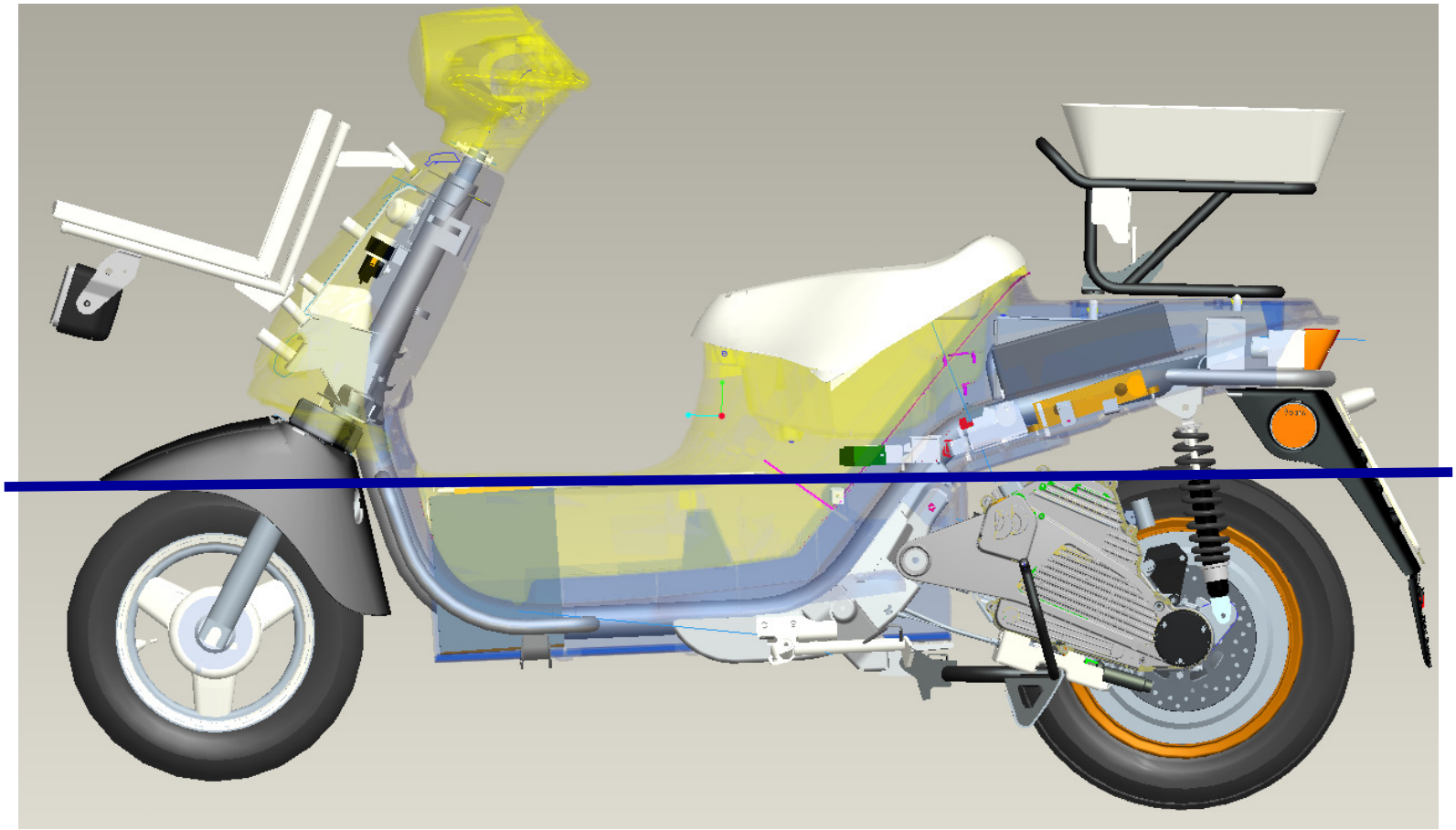
CHARGER
Universal Hi-frequency 1 KW
On board battery charger

SENSORED ELECTRIC MOTOR
3 phase AC Brushless motor
900 rpm
150 Nm peak torque
Two sin/cos Hall sensors

SHOCK ABSORBER SYSTEM
4 position adjustable

Main Drive Train Components Placement

The most heavy drive train components are placed close to the ground.
The battery charger and the tray are placed in a water protected compartment
We minimize the power cabling length and we maximize the scooter handling and carrying capability

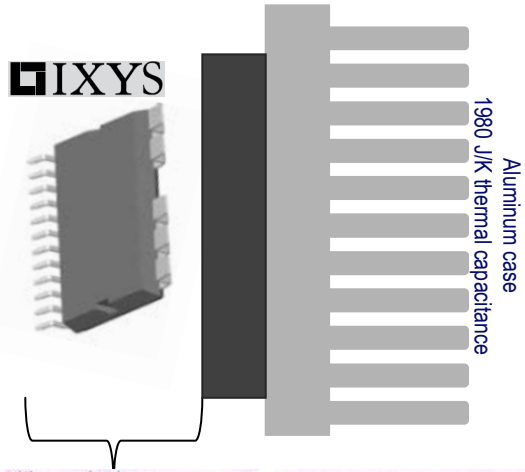


Low CoG
All heavy weights
below this line
(about 70% of the total weight)

Oxygen motor system

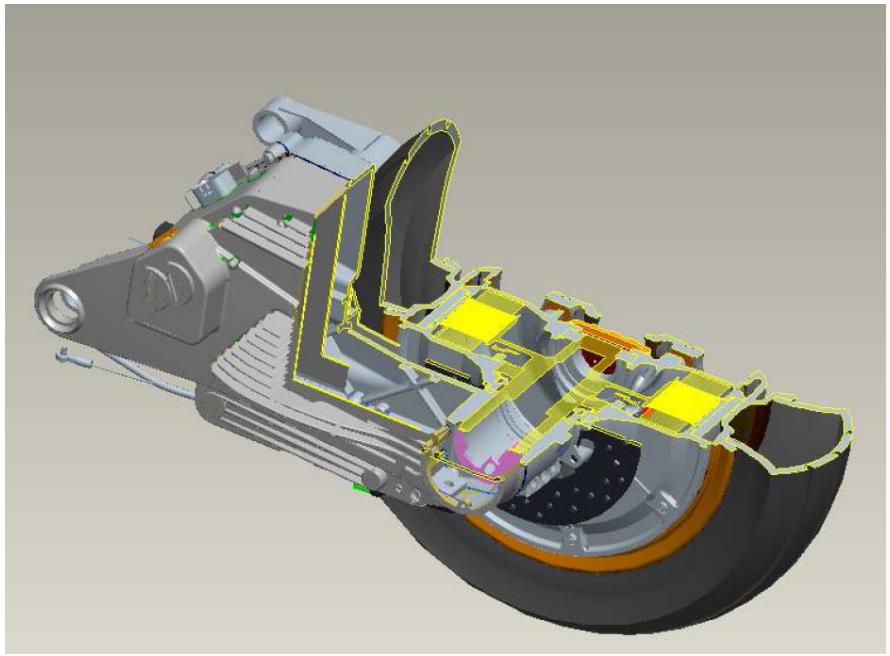
Oxygen designed a very compact motor system in order to:

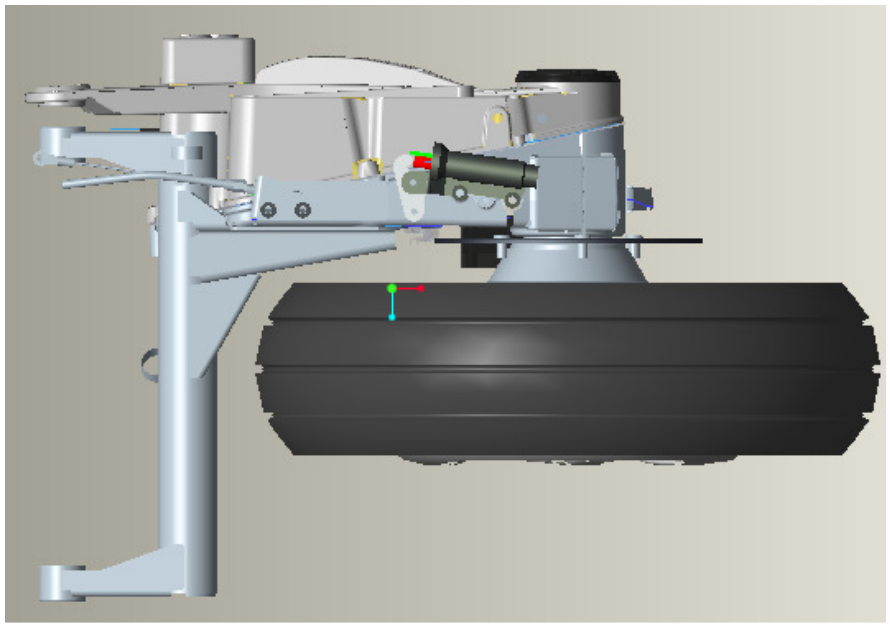
- Minimize cabling length
- Optimize the thermal management especially in power peak
- Optimize the production and quality control process
- Saving space on the scooter in order to maximize the battery compartment
- Have a very simple wheel maintenance
- Have the integrate braking system

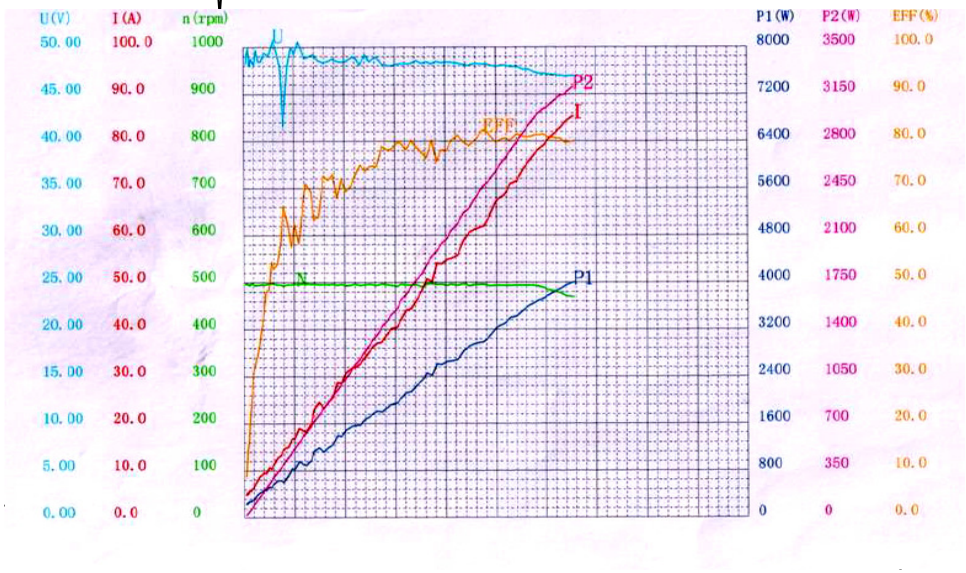


Full aluminum finned case:
-Light and corrosion resistant
-Top notch thermal performances

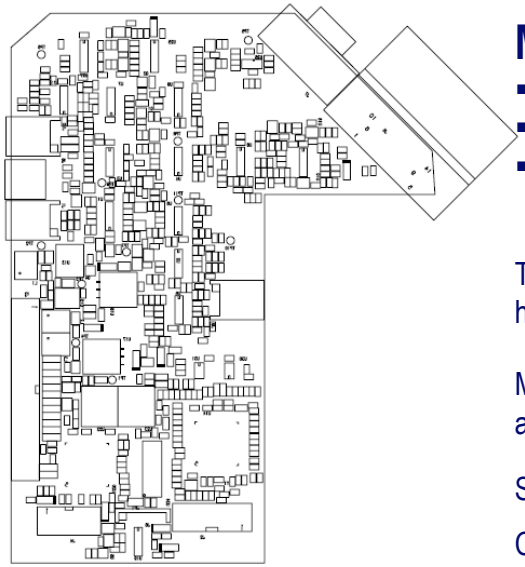
Structural aluminum arm:
-Wheel support
-Drive support







Motor Control Drive



MULTIPLE BOARDS APPROACH:

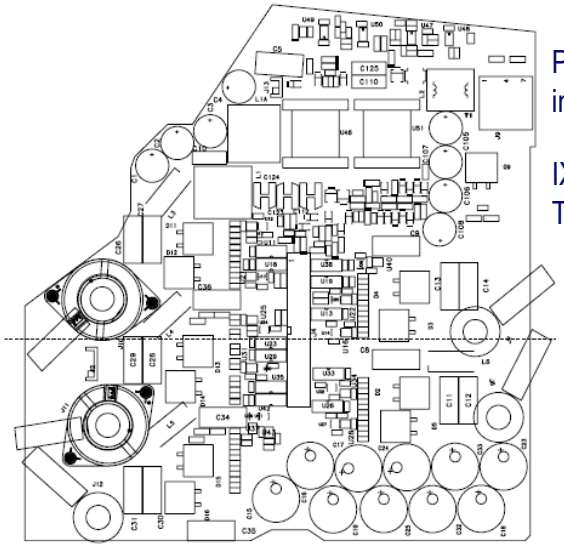
- Flexibility
- Power/Logic isolation
- 3D construction

Texas Inst. TMS320F2808
high performance DSP

Multiple motor control modulation algorithms

Scooter specific I/O lines

CPLD controlled
safety redundancy system



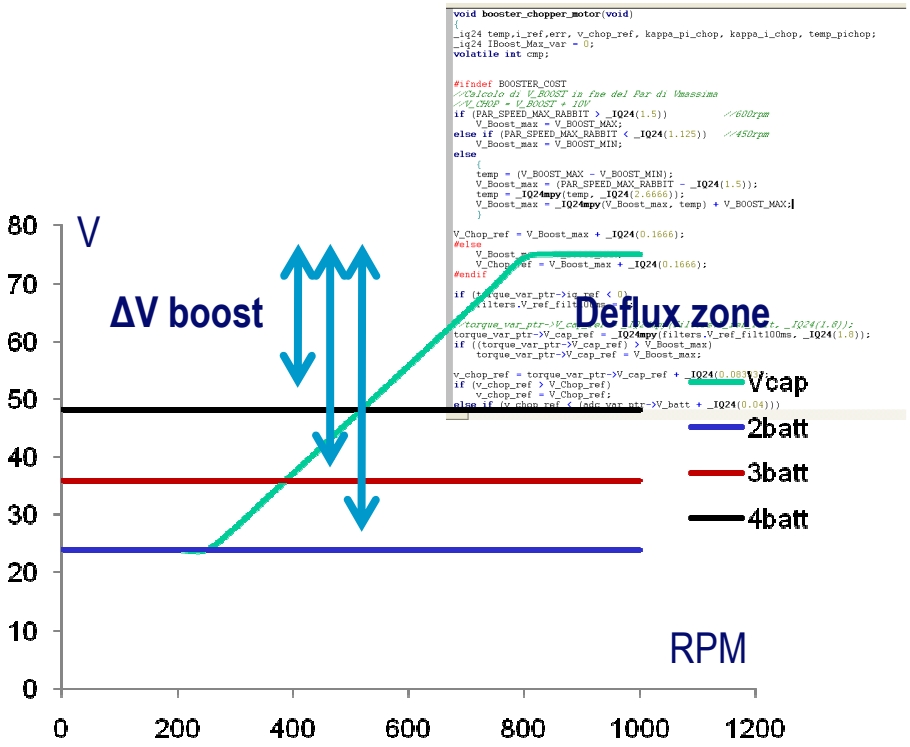
Pre-charge and brake resistors included in drive's case

IXYS GWM100-01X1-SMD
Trench gate MOSFET modules

DOUBLE STAGE ARCHITECTURE

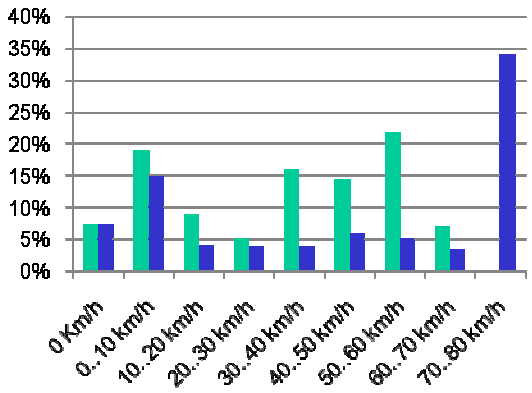
Double stage motor control architecture advantages:
-Ultra wide input voltage range
-Stable output voltage (not depending on battery impedance)
-Ultra wide speed range regenerative braking
-High efficiency, motor speed range extension

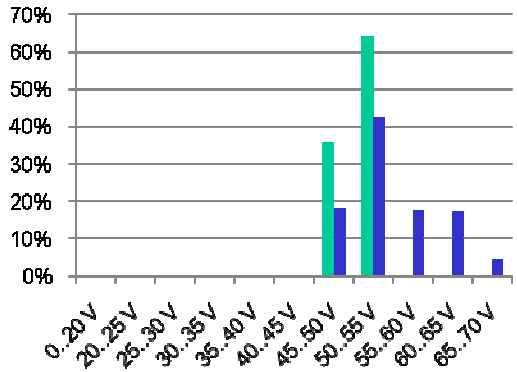
Double stage motor control architecture function principles:
-Booster and deflux strategy combined to achieve higher motor speed and high motor torque at very low speed
-Booster give optimal bus voltage for each speed range
-Motor speed is only limited by MOSFET max Vdss

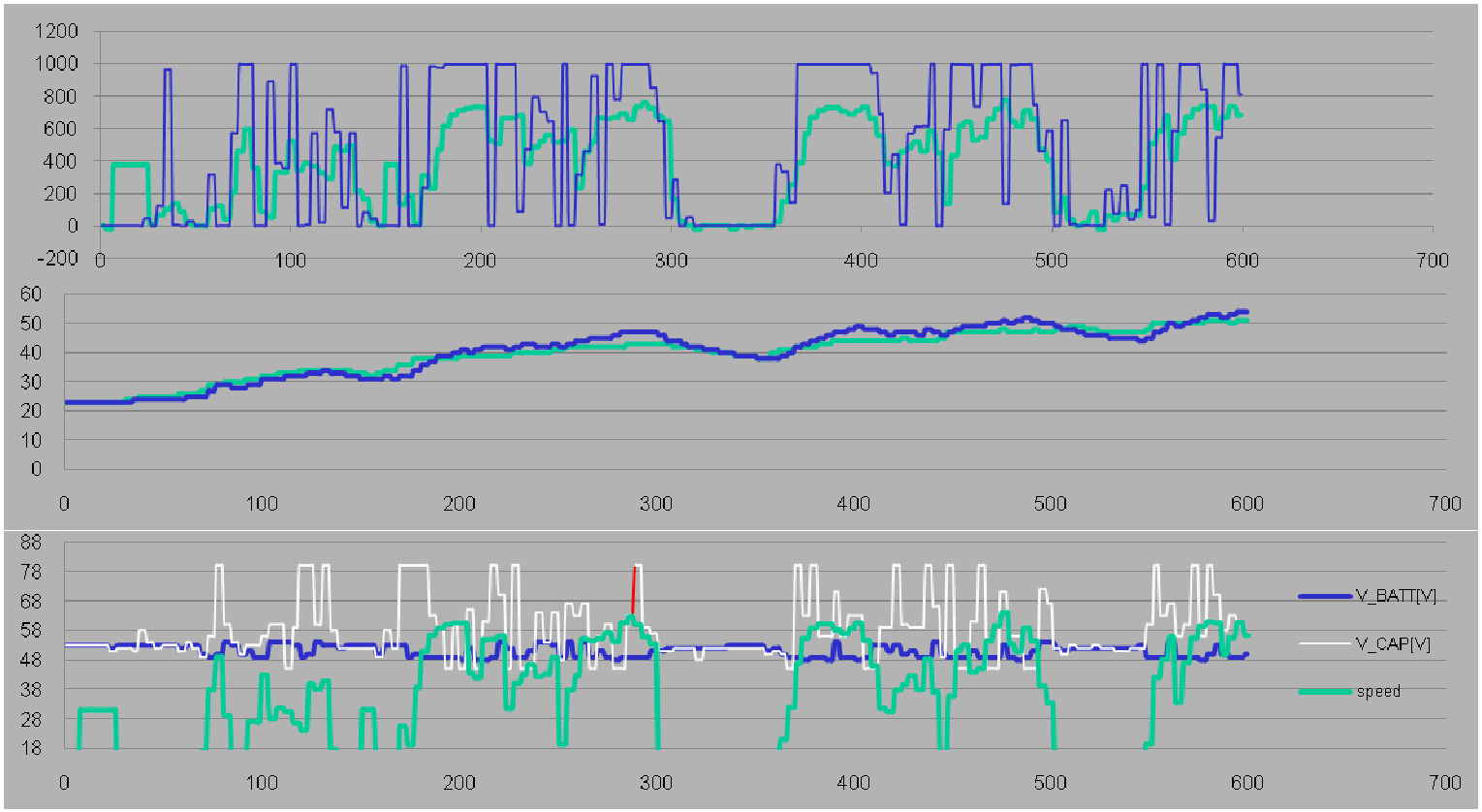


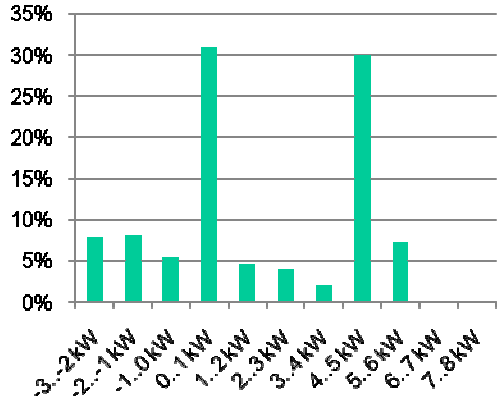
Data logger sample (CargoScooter hi-speed prototype)

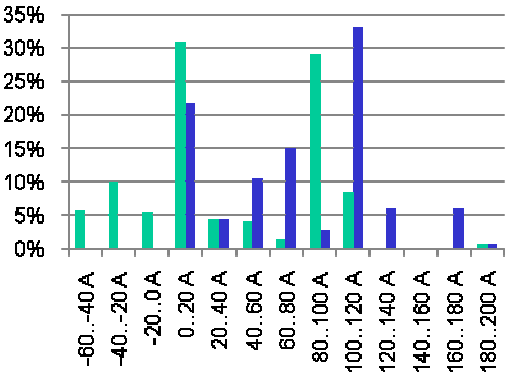
TEST DATA		
Total time	h	0,17
Rest time	h	0,02
n° stop and go	n°	11
range	km	5
Battery energy pick up	Wh	357
Regenerative braking energy	Wh	-60
Energy consumption	Wh	296
Consumption	Wh/km	57
Average speed (rest time ex.)	km/h	36











Custom CargoScooter

- Several Front and Rear load Configurations

- Range extension

- Performance mapping

Custom CargoScooter

- GPS
- Fleet management system
- Fast charge unit
- Custom color and graphics
- Custom courtesy sound