



# Intelligent Energy

SHIFT 2007  
September 19<sup>th</sup> 2007



**INTELLIGENT ENERGY**  
*Clean fuel and power*

©2007 Intelligent Energy Limited

The information in this document is the property of Intelligent Energy Limited and may not be copied or communicated to a third party, or used for any purpose other than that for which it is supplied without the express written consent of Intelligent Energy Limited.  
This information is given in good faith based upon the latest information available to Intelligent Energy Limited, no warranty or representation is given concerning such information, which must not be taken as establishing any contractual or other commitment binding upon Intelligent Energy Ltd or any of its subsidiary or associated companies.

Intelligent Energy is a UK based developer of advanced PEM fuel cell system designs (stacks and balance of plant), with world leading power density and unique thermal and water management features.

Intelligent Energy's team of technologists is one of the longest established anywhere in the world and includes several members with automotive experience who were recently involved in the design and production of the ENV concept motorcycle, built around its PEM fuel cell system, which has won several design awards.

Intelligent Energy's business model is to partner with leading companies to develop fuel cell systems to meet the partner's application requirements and give them a competitive advantage in their chosen market sectors.

*enV*

ENV was originally conceived purely as a  
**technology demonstrator**

a live platform to display  
the unique capabilities of

**Intelligent Energy Fuel Cells**

# Background

- Intelligent Energy decides to build technology demonstrator
  - to show FC technology is here now, not a futuristic ideal
- Management workshop chooses lightweight motorcycle to meet certain objectives
  - to excite consumer interest by beauty of concept styling
  - to use this excitement to draw attention to fuel cell technology
  - to show compact packaging of unique fuel cell system

# Key considerations in producing a fuel cell two wheeler?

- packaging the system into the limited space available
- keeping weight to a minimum
- maintaining simplicity
- cost

# the ENV bike solution

ENV incorporates a 1000W system in a striking modern motorcycle design....





...using a detachable Core designed to power multiple applications



# Market reaction

Enormous interest generated

- consumers
- journalists
- potential business partners

Media tracking shows 340 million audience

- via print, tv, radio, web

The Americas, Europe, Asia, Australasia, Island economies

Enquiries continue at steady rate, peaking around media splashes

# ENV



## Specification

Motor 6kW, 48 VDC Compact Brushed motor air-cooled  
Fuel cell 1kW Intelligent Energy air-cooled  
Storage battery 4 x 12V Lead Acid (15Ahr)

## Performance data

Acceleration 0 – 20 mph in 4.3s (32kph)  
0 – 30 mph in 7.3s (48 kph)  
0 – 50 mph in 12.1s (80kph)  
Top speed 50mph (80kph)  
Range ~ 100 miles (160km)

## Physical

Bike mass 80 kg

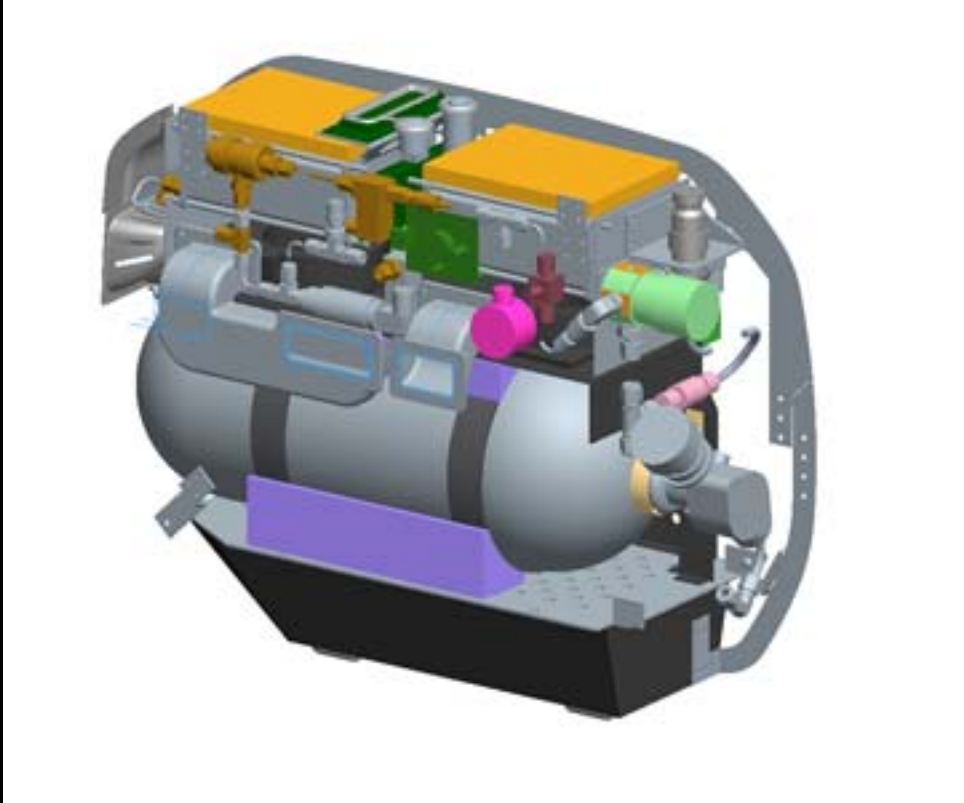
## Fuel

Hydrogen storage High pressure composite cylinder (Luxfer L65)  
Hydrogen energy 2.4kWh

# 1000W (2.4kWh) power module for ENV motorcycle

- Physical
  - Size (mm): 180 x 320 x 550
  - Weight: 15kg
- Power Delivery
  - 1000W
  - 24V D.C.
- Sound level
  - <45dB @ 1 metre





# Air Cooled Stacks and Modules

- Suitable for applications 20W – 3kW
- Application coverage for small vehicles, mini UAVs, portable power
- Requires minimal balance of plant
- Can be packaged with H2 supply and control system as 'slot-in /slot-out' power module



Stacks

# 750W Packaged Fuel Cell Module



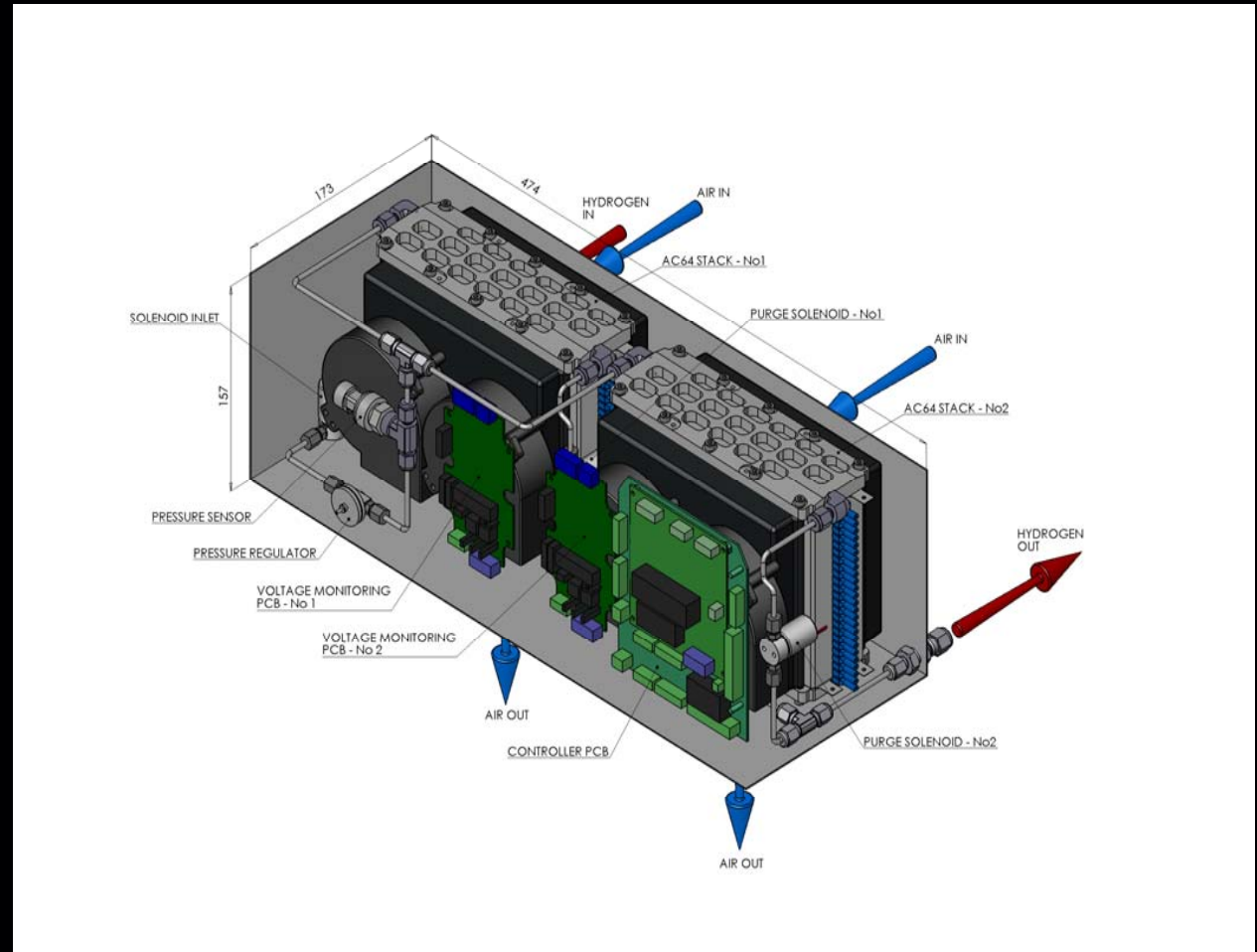
Module including air delivery system, cell monitoring and control electronics.

Mass of complete module approximately 3kg

# 1.3kW Packaged Fuel Cell Module (Complete hydrogen in electricity out)

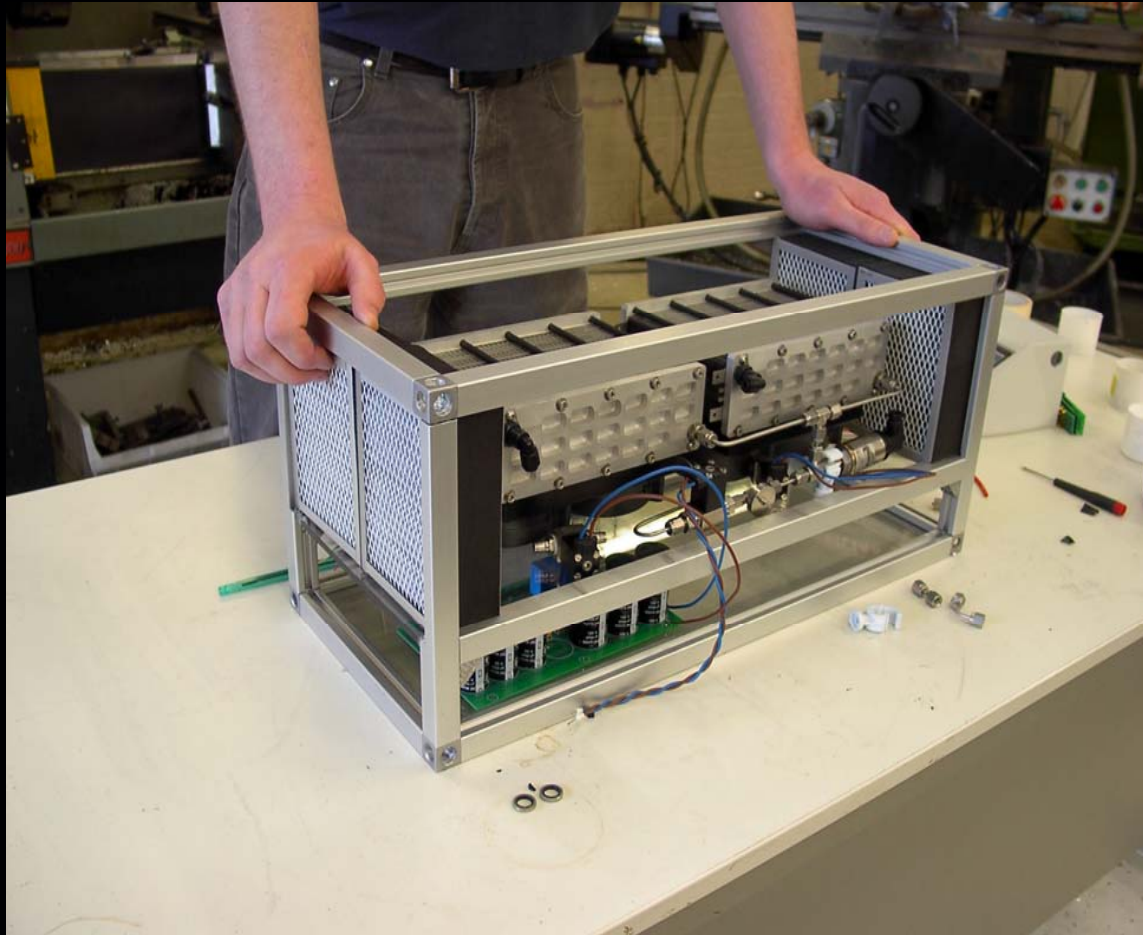


High efficiency power electronics (>95%) matched to twin stack system. System is programmable and can be operated as a battery management system.





# 1.3kW Packaged Fuel Cell Module (Complete hydrogen in electricity out)



1.3kWe system under construction for small hybrid vehicle application.

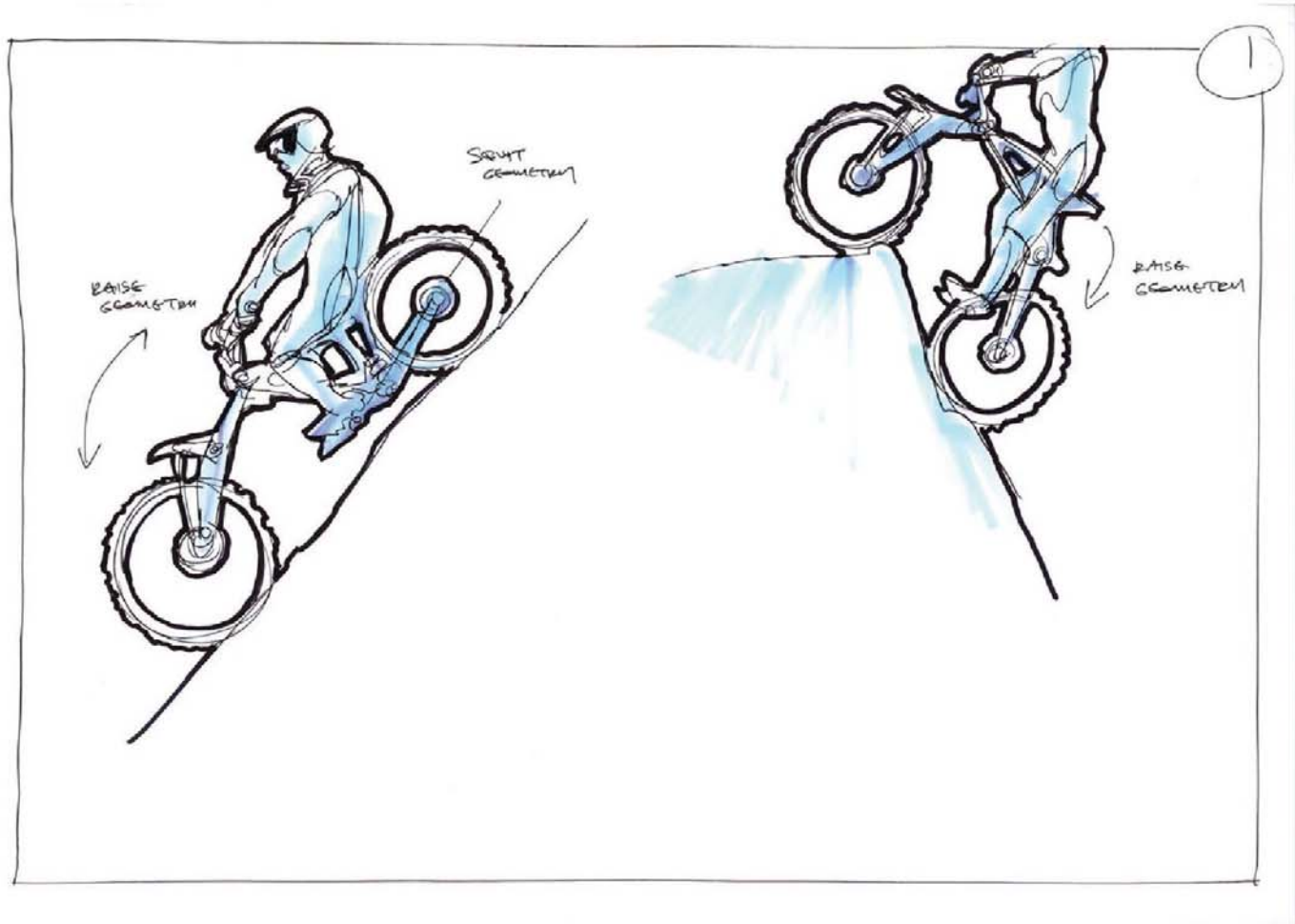
# Fuel Cell System - Technical Summary

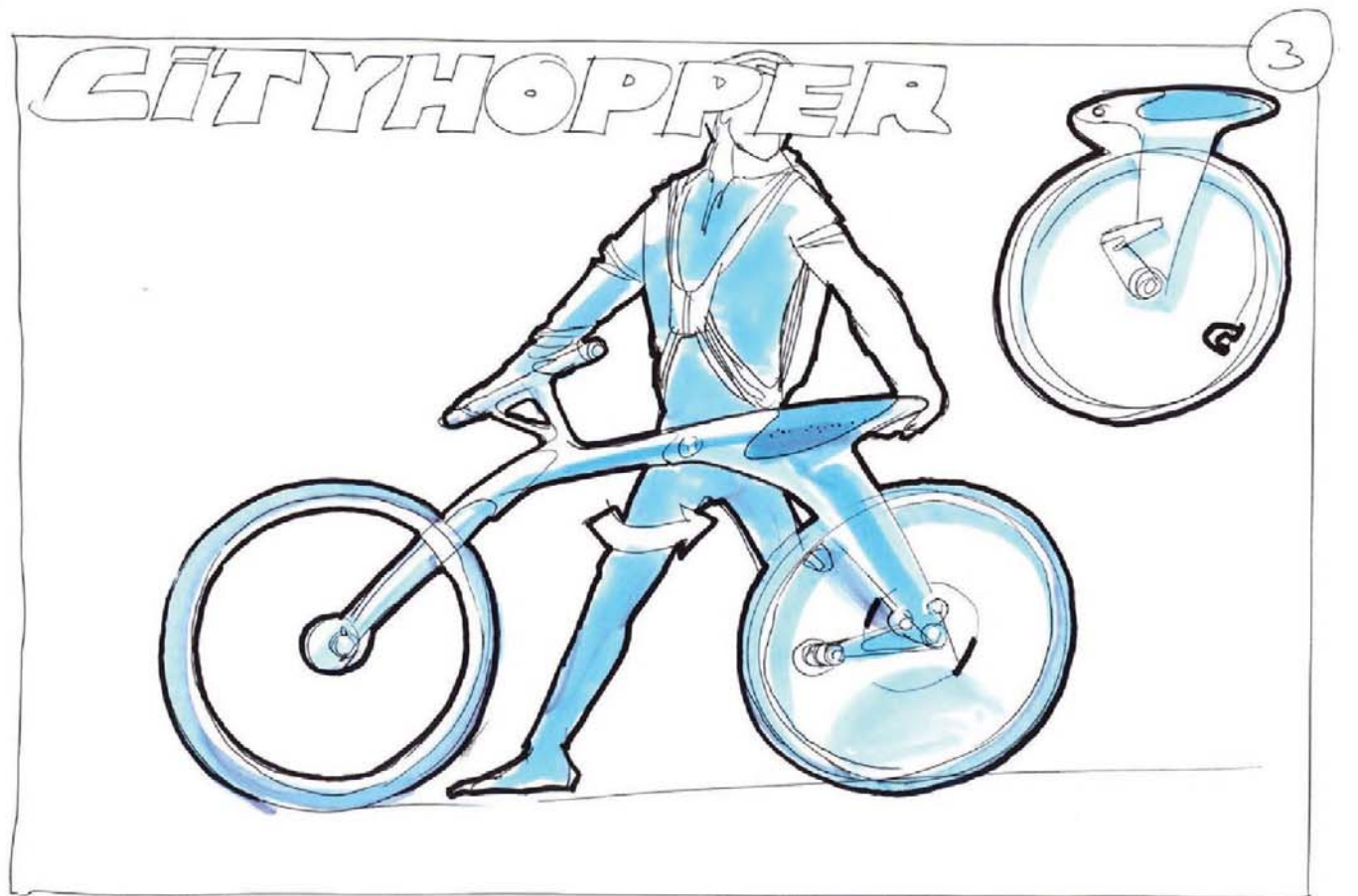
- Very simple BOP
- Low parasitic power
- Air cooled design no radiator required
- Fully pressed plate design for low cost mass production
- Long life expectancy
- Compact self-contained design
- High hydrogen utilisation
- Lightweight and robust

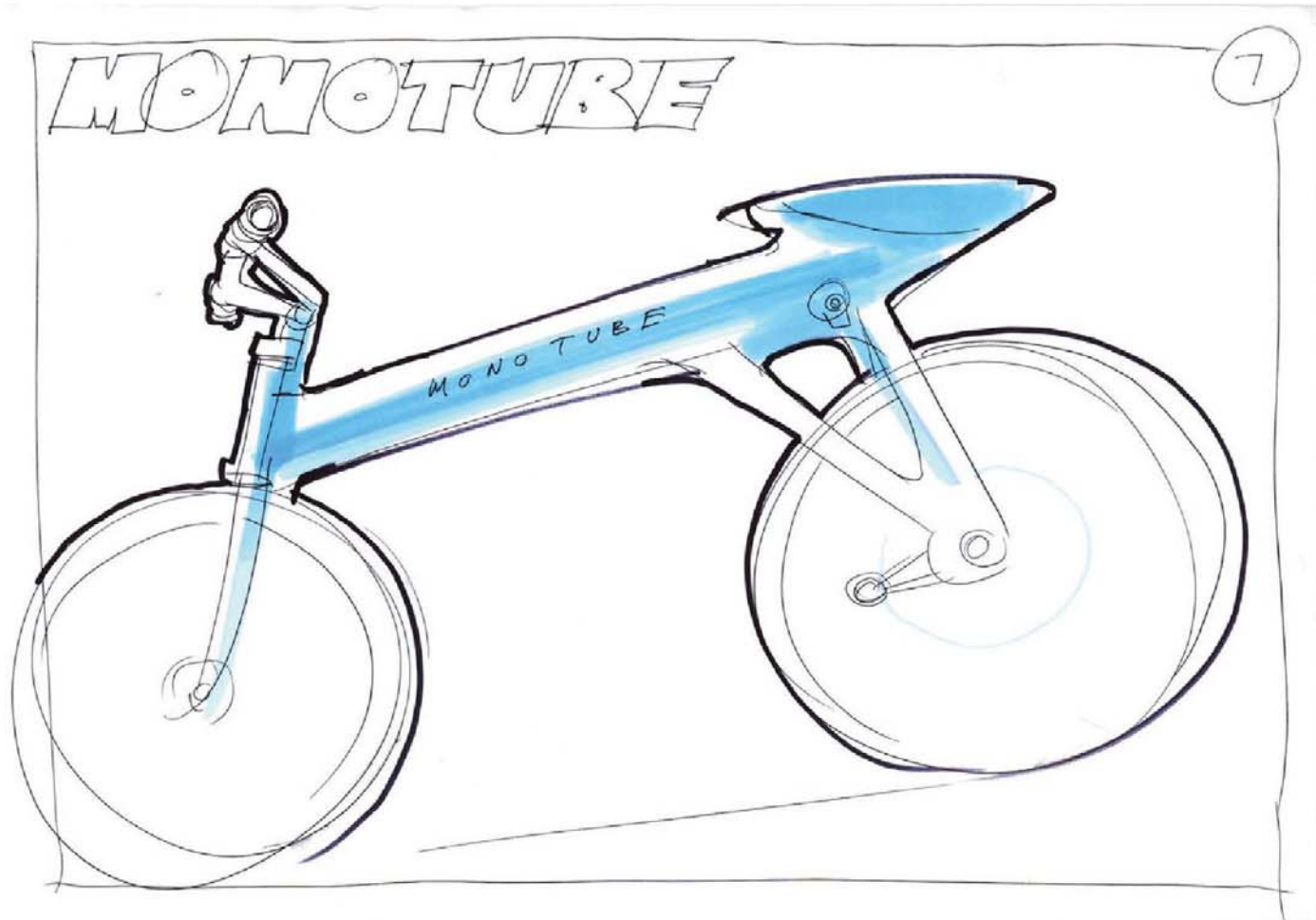
# the evolution of the ENV bike

... from concept(s)

Crucible Event | **Concept**

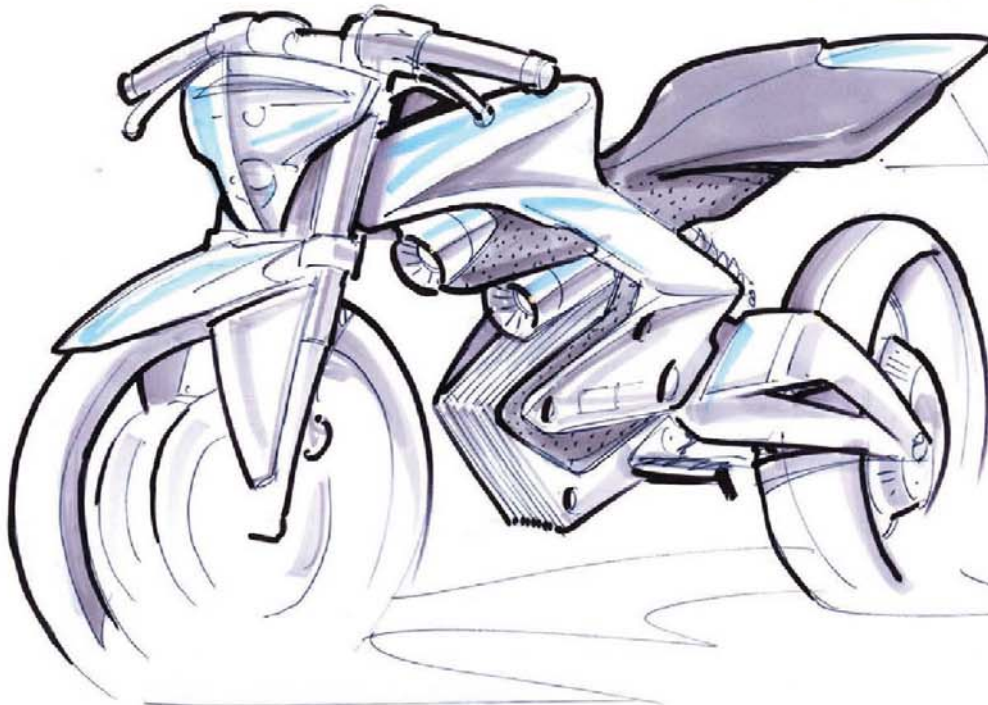






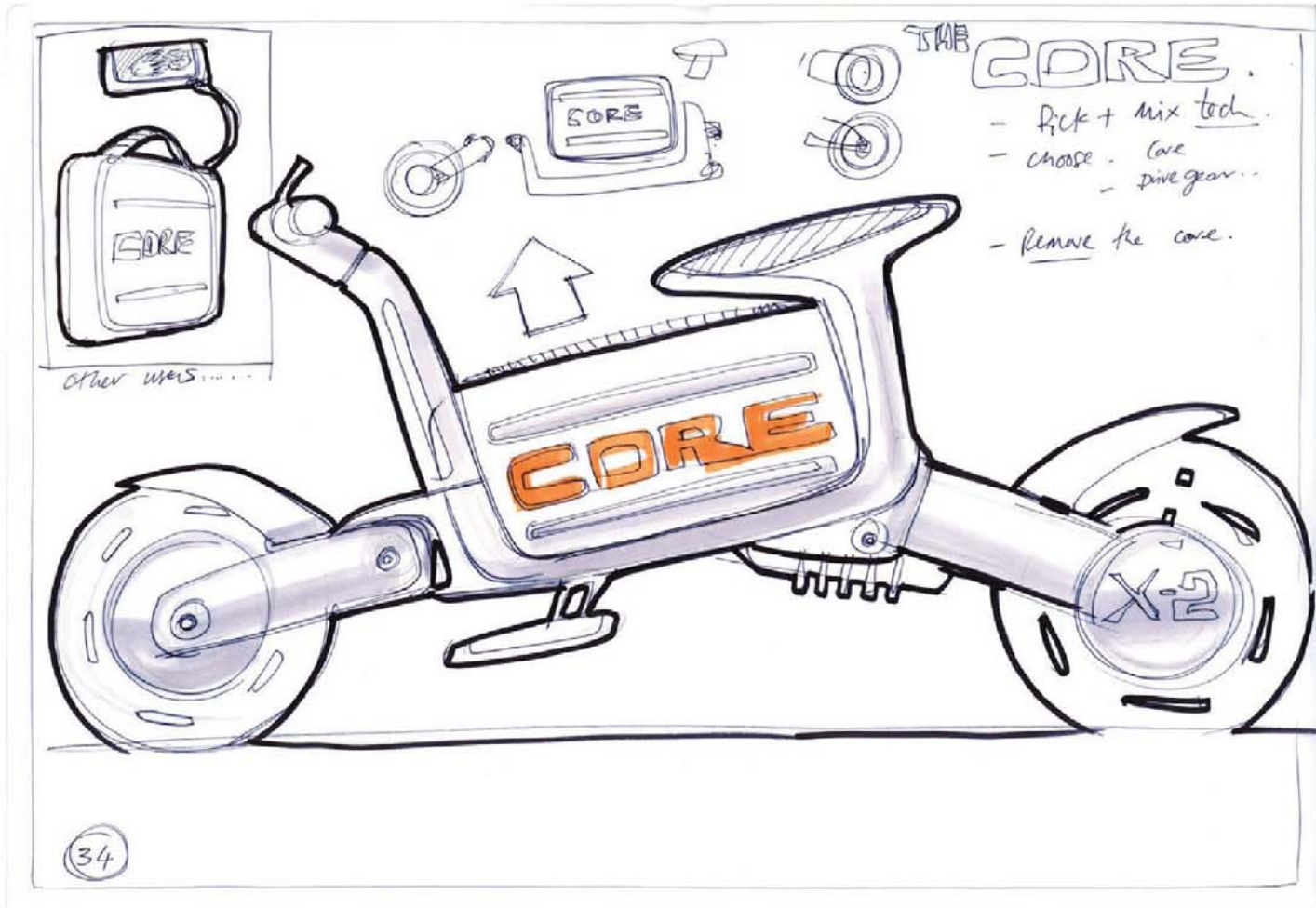
31

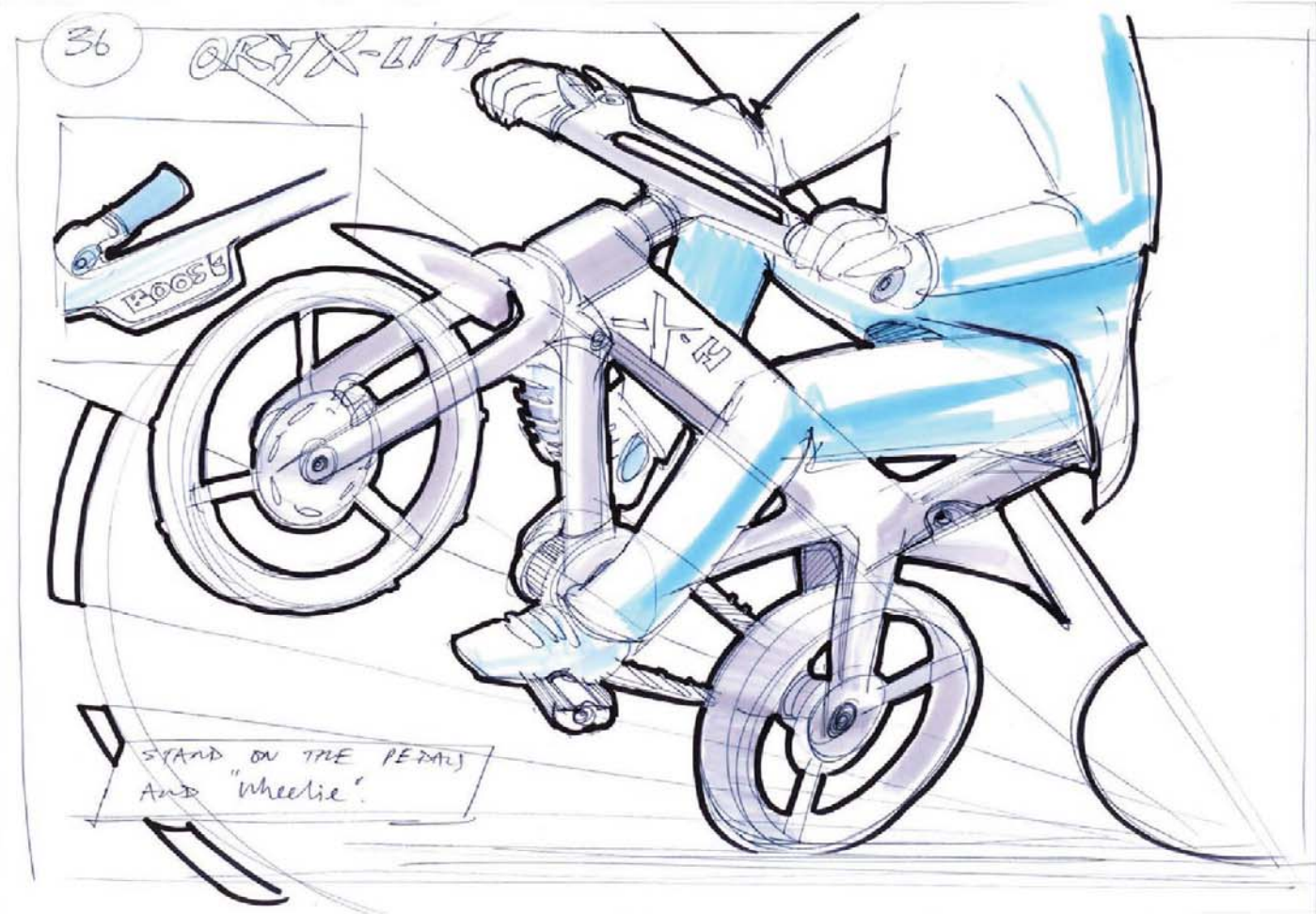
*Green +* **MEAN**

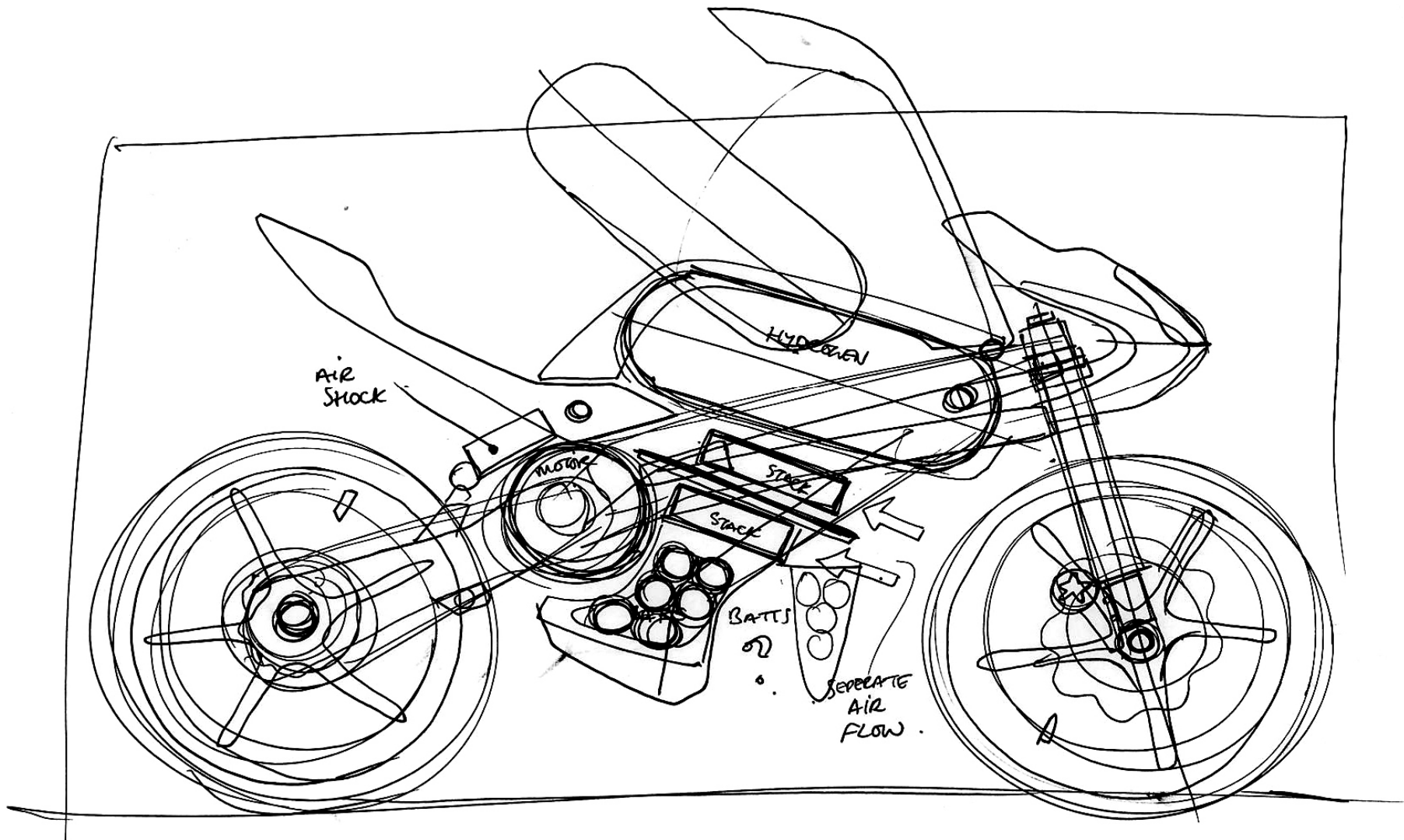


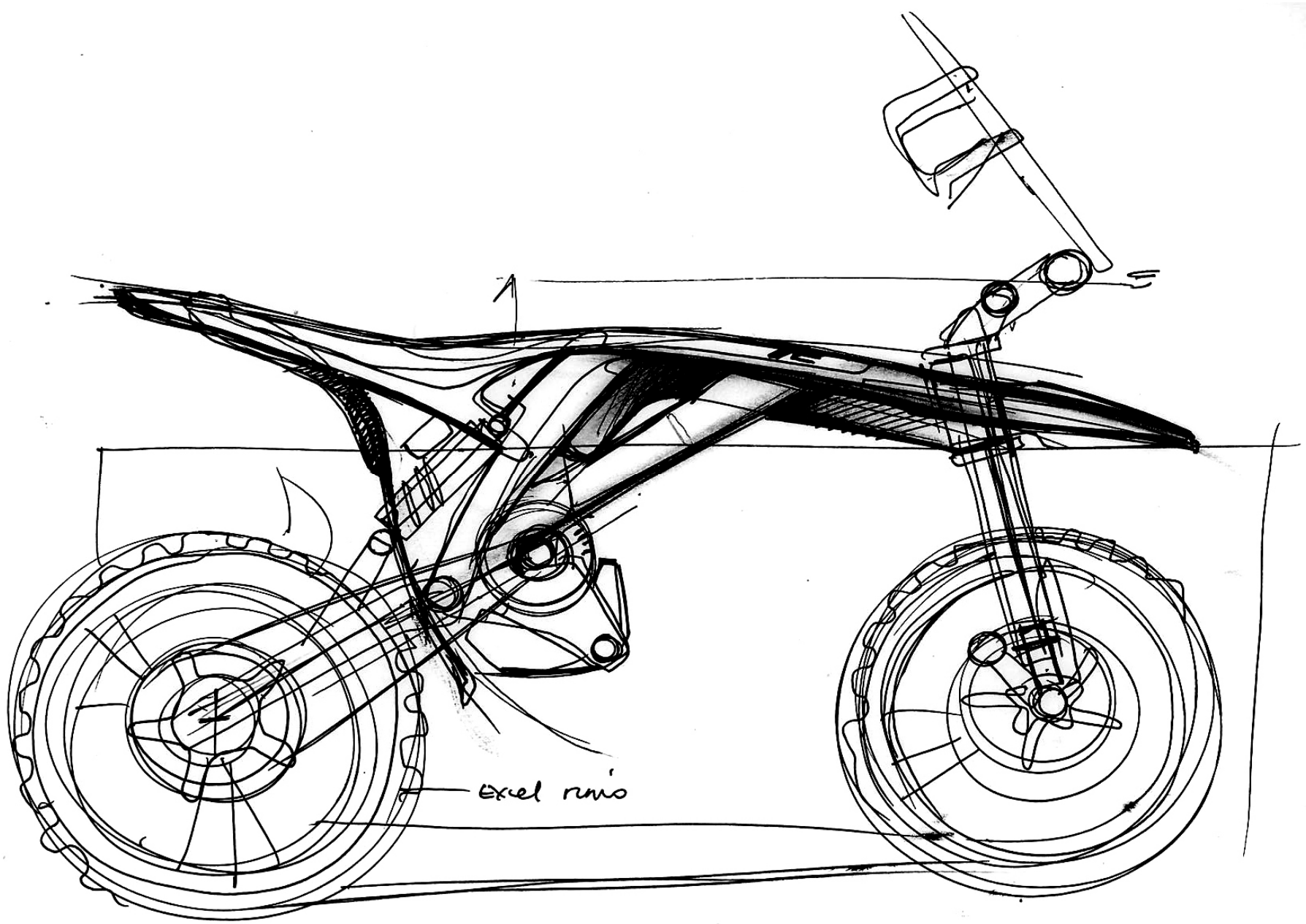
- CLEAR I.E. ENGINE TECH + LANGUAGE
- ECO-FRIENDLY WITH ATTITUDE
- SKELETAL, EXPOSED
- HYBRIDE 'MUSCLE'

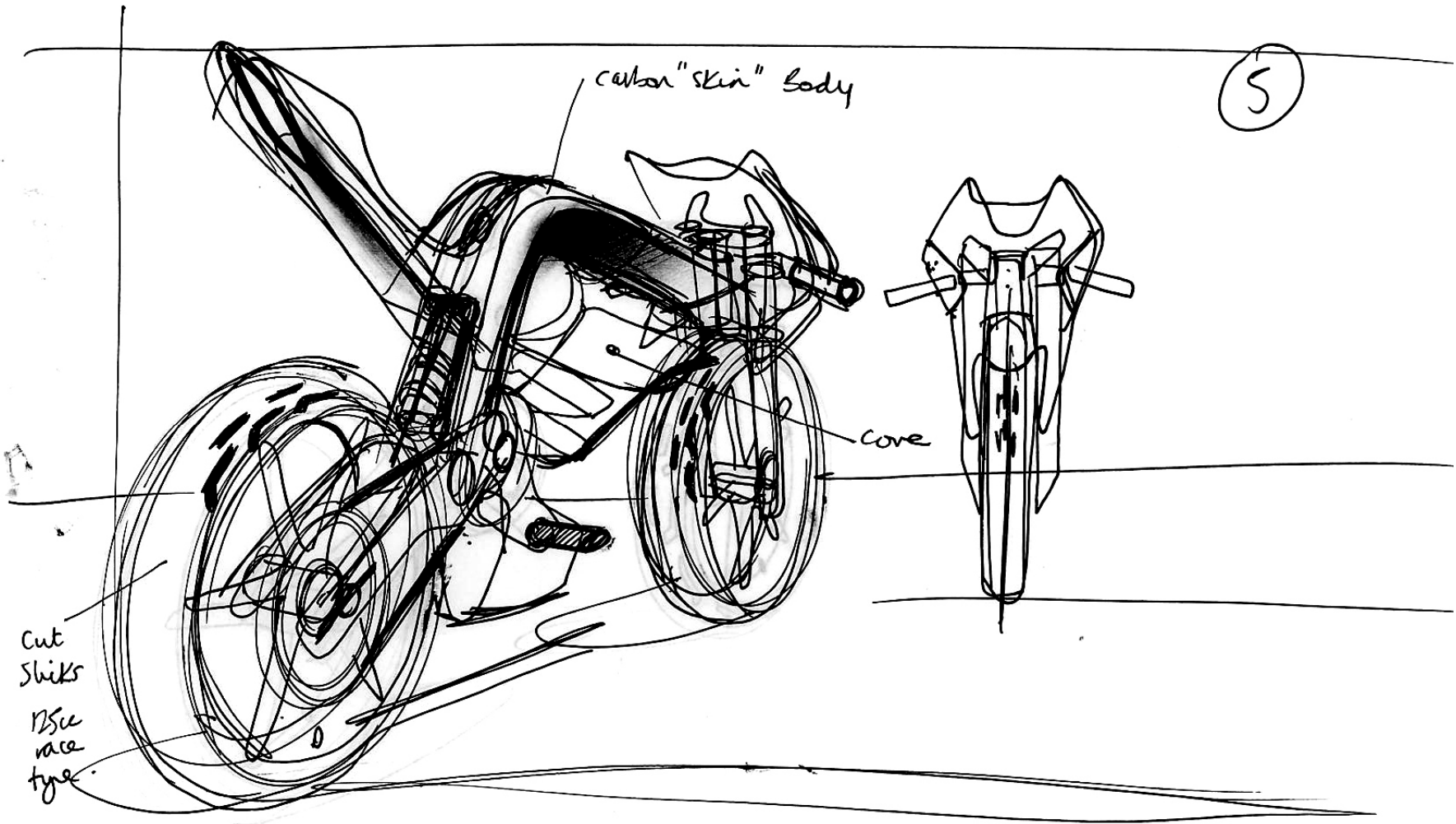


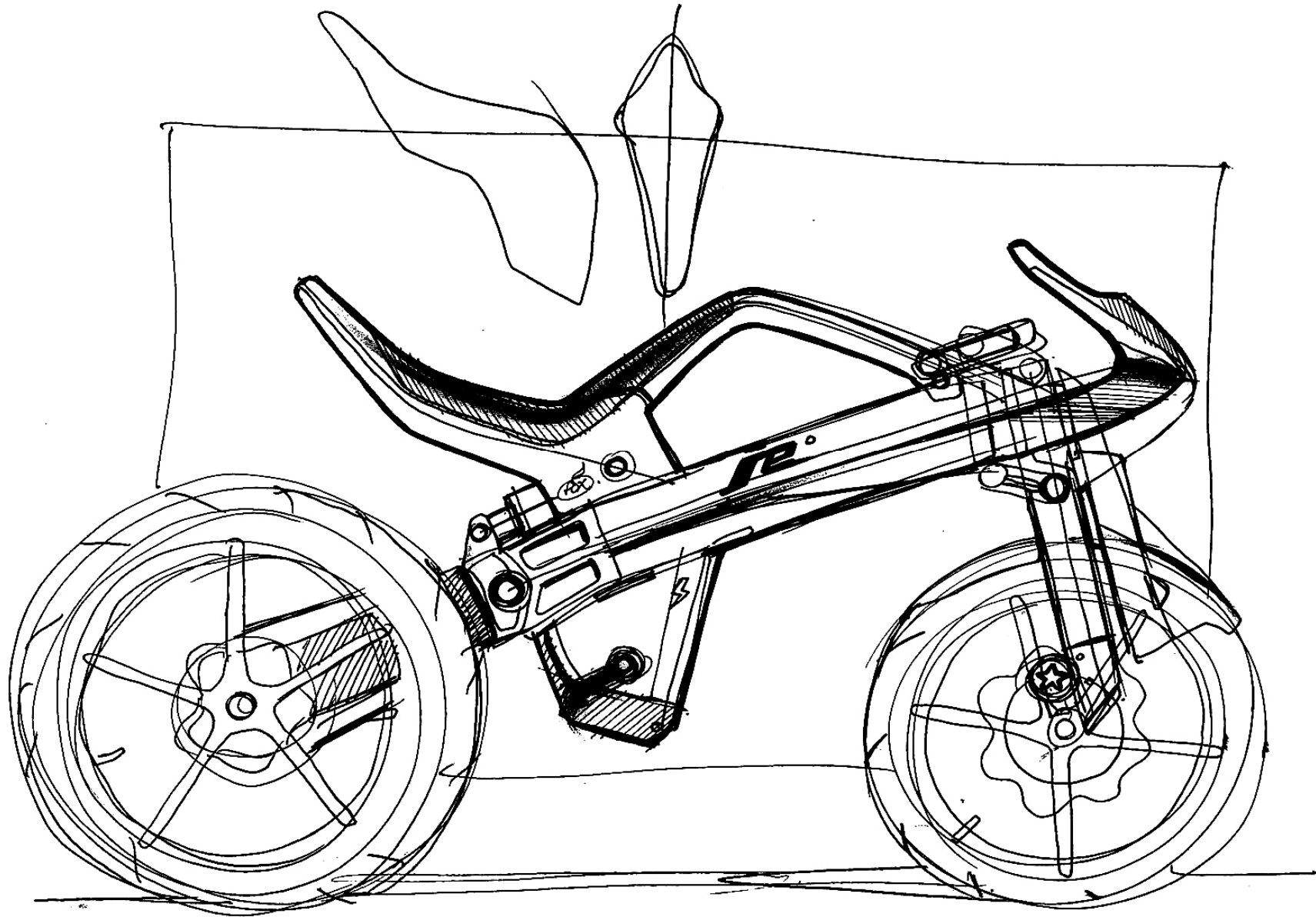


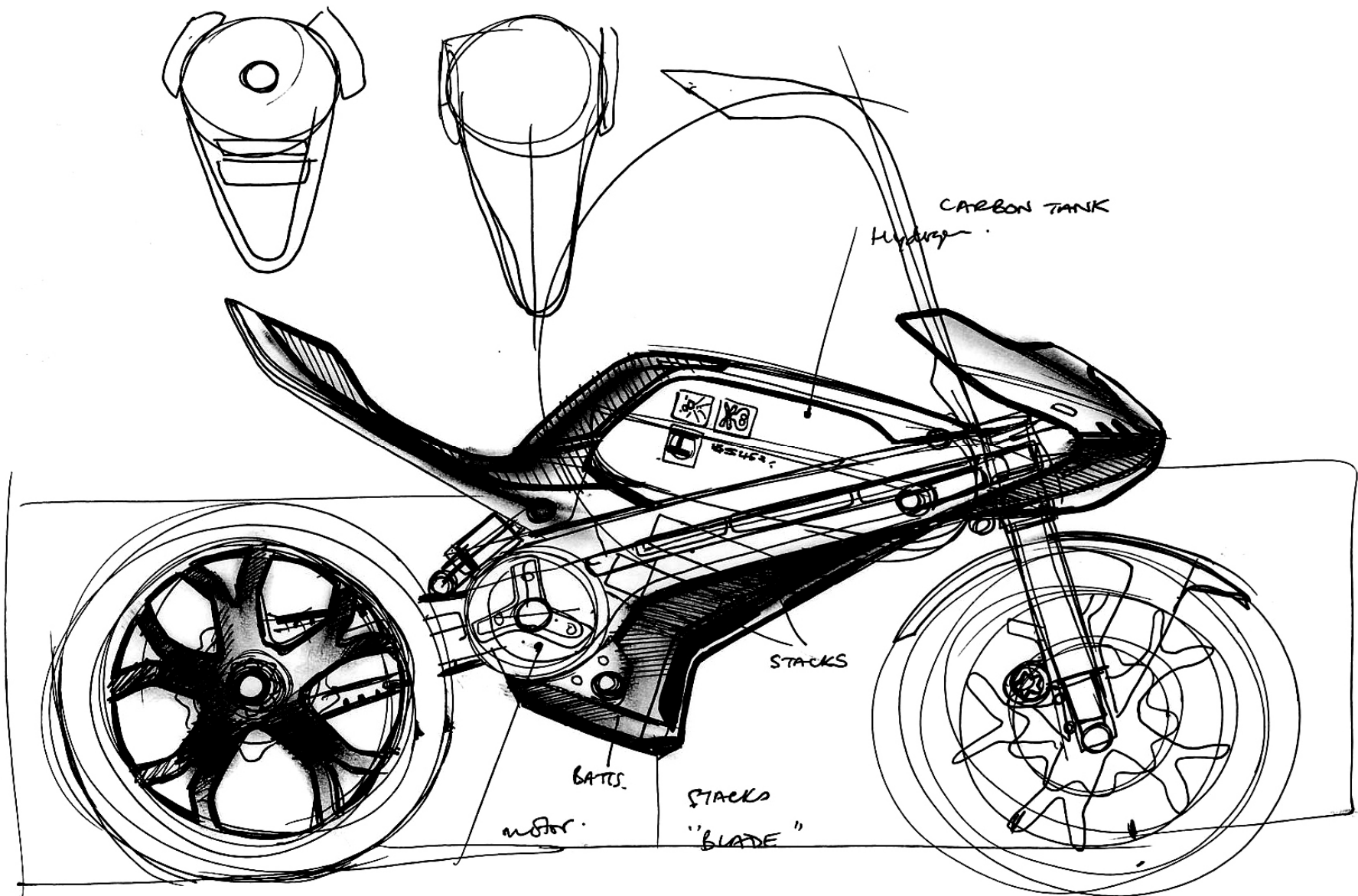


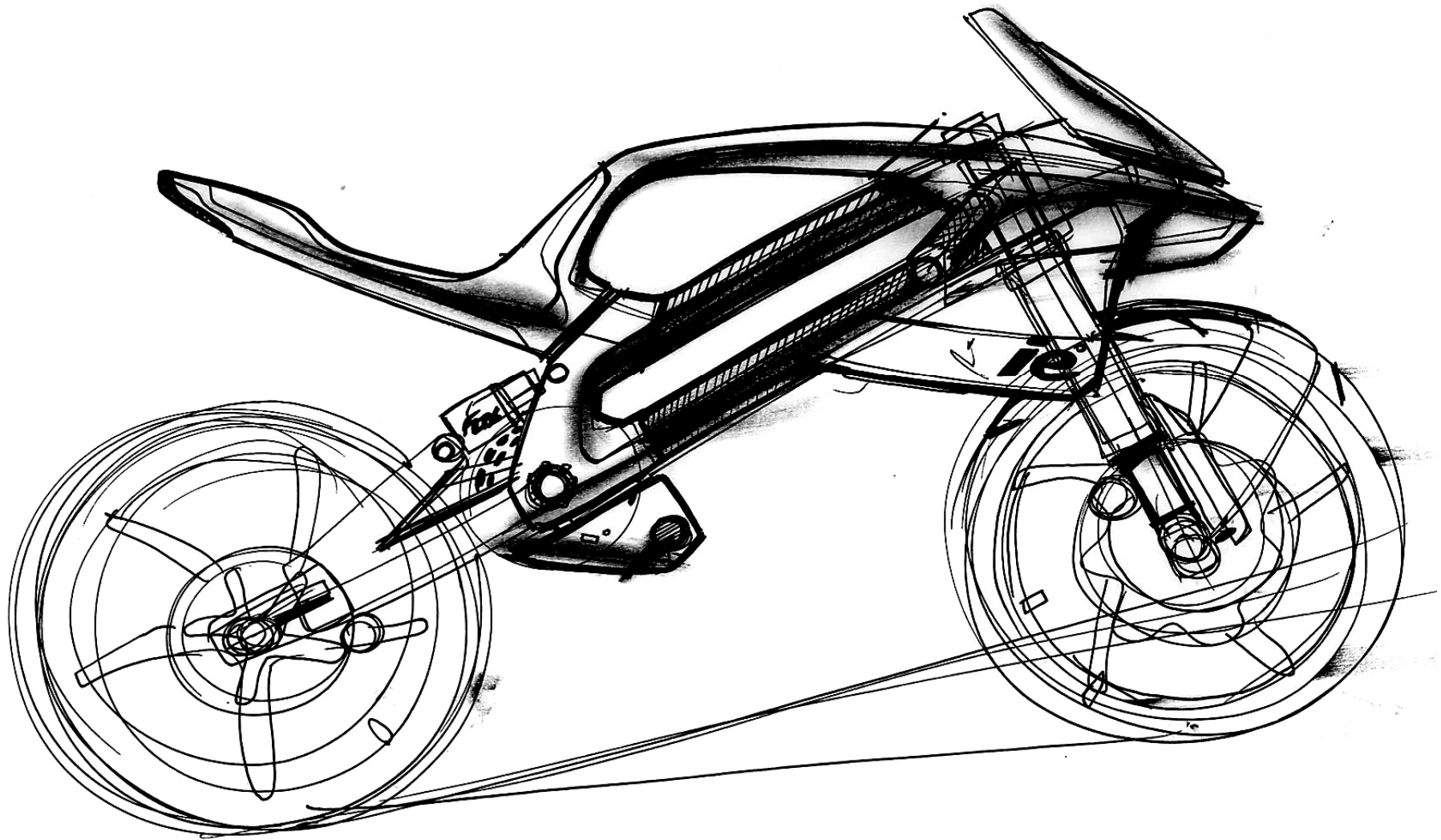
























... to reality

















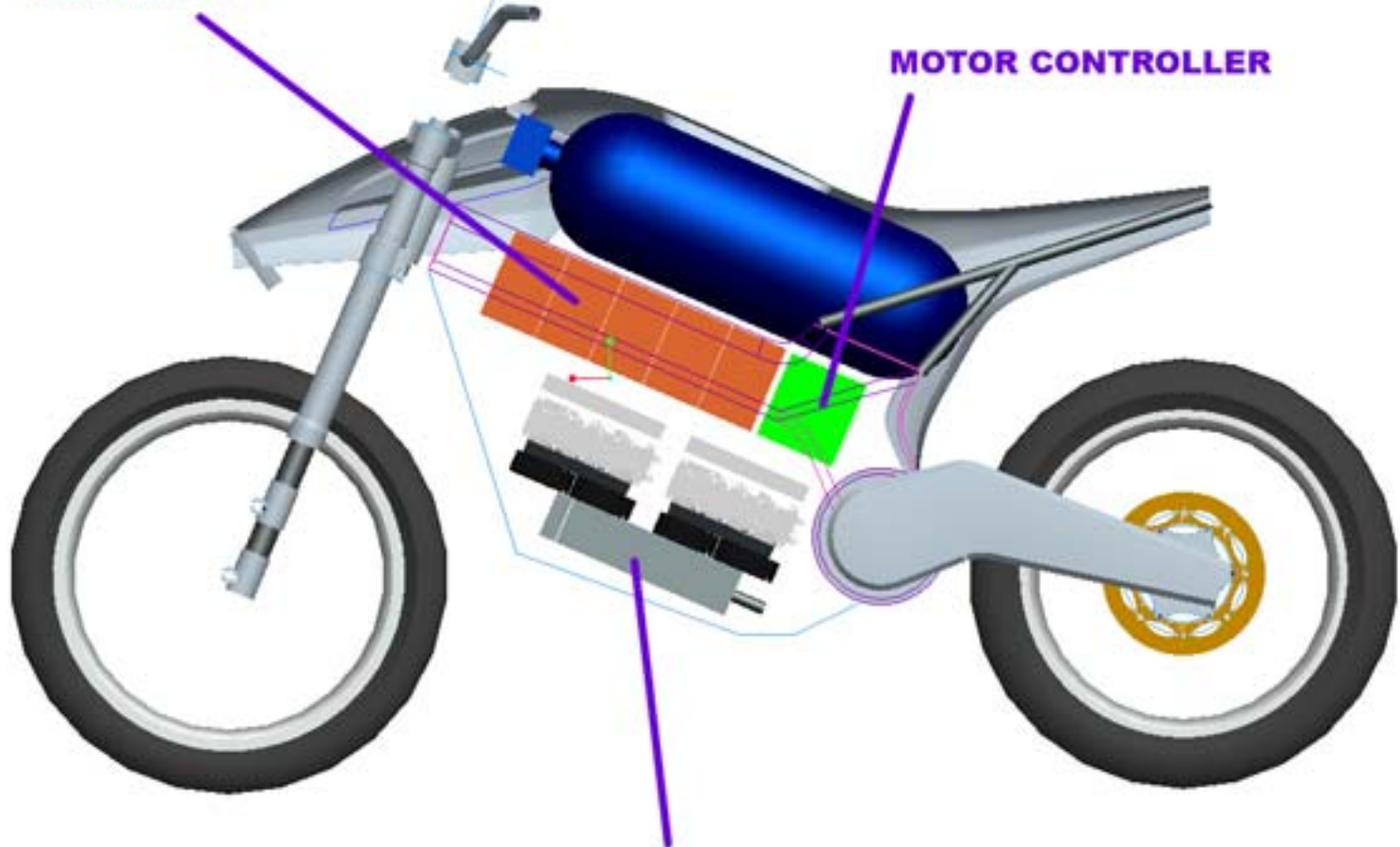


What Next?

learning, iteration, development,  
and certification

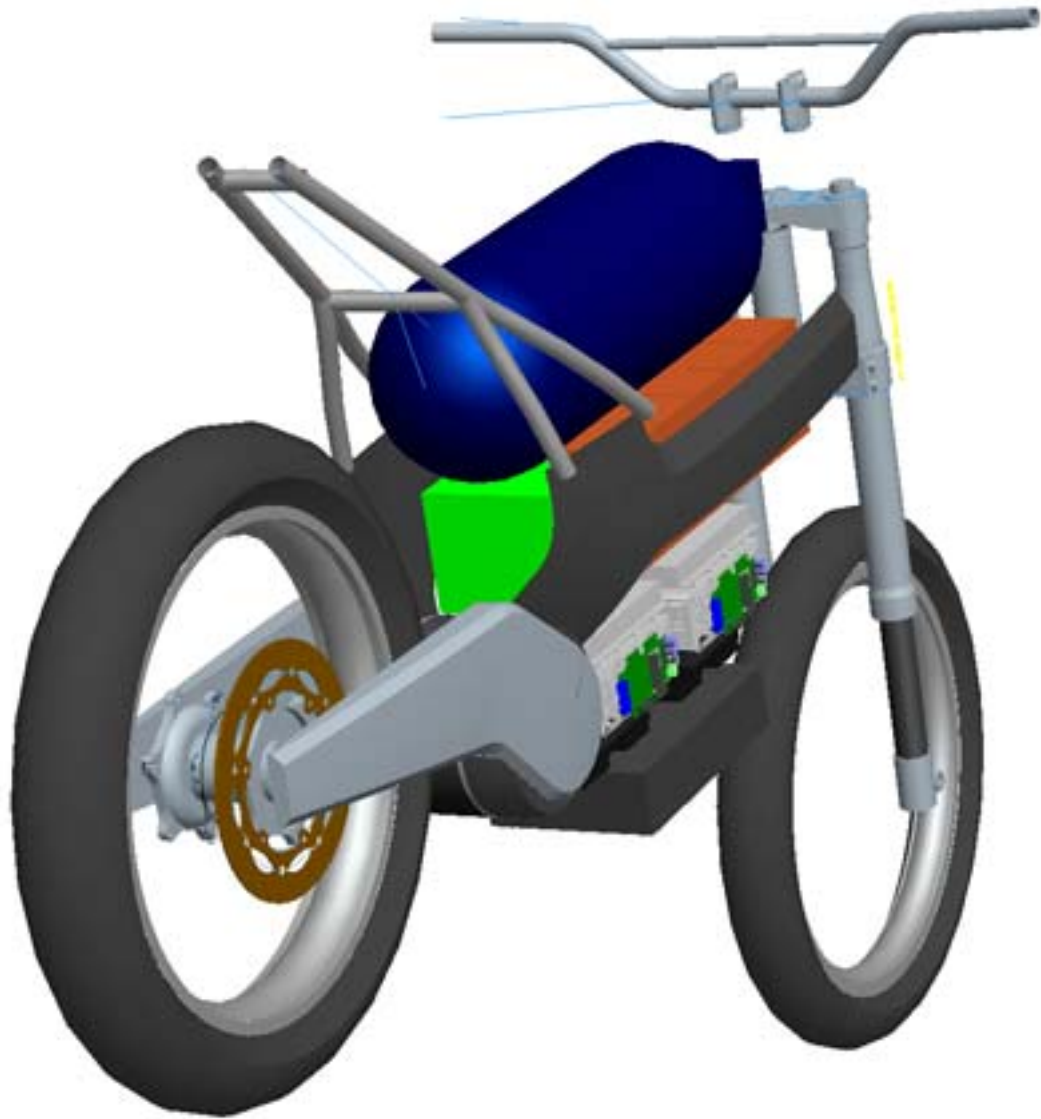


**5 X 12VOLTS**

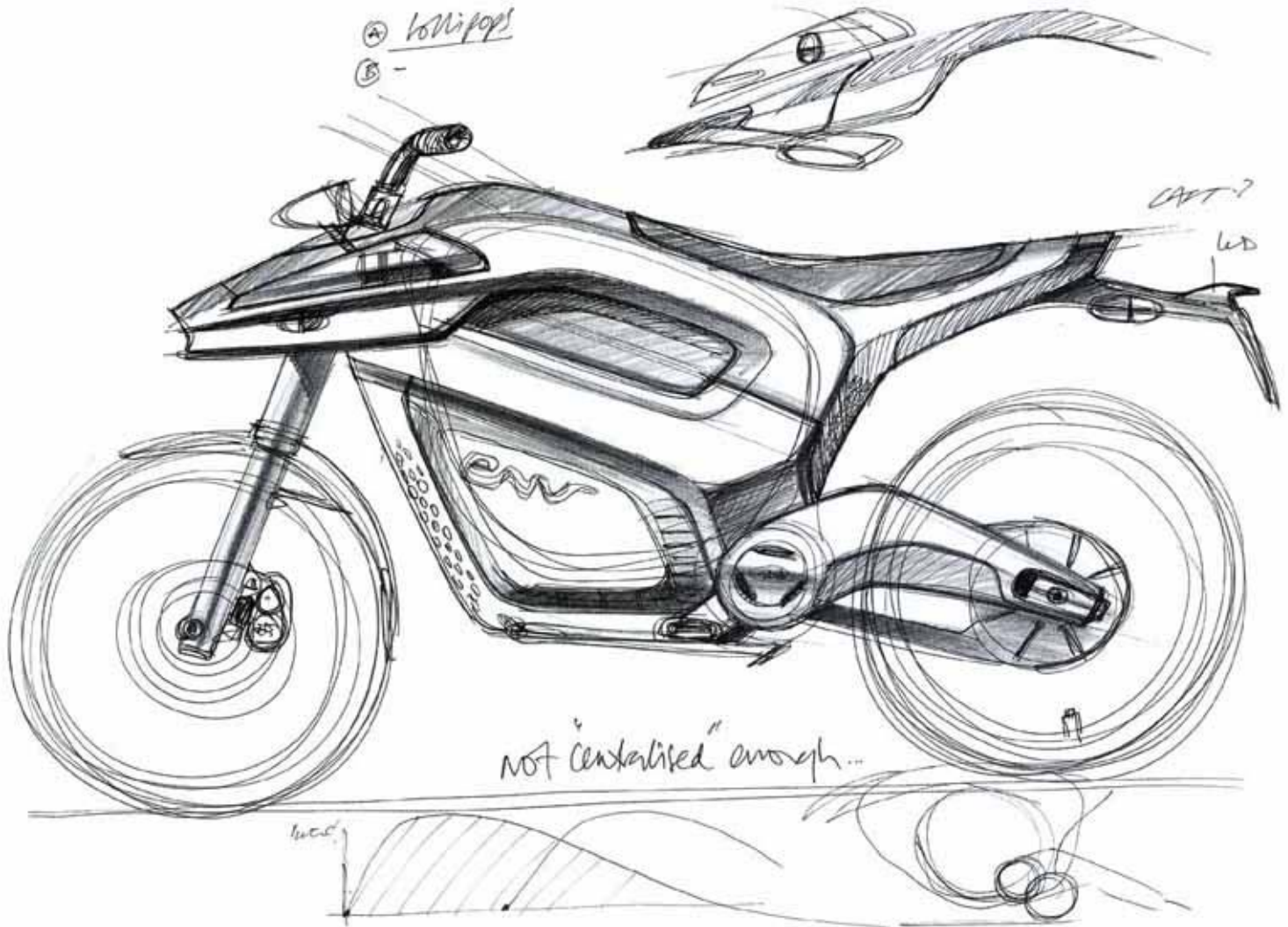


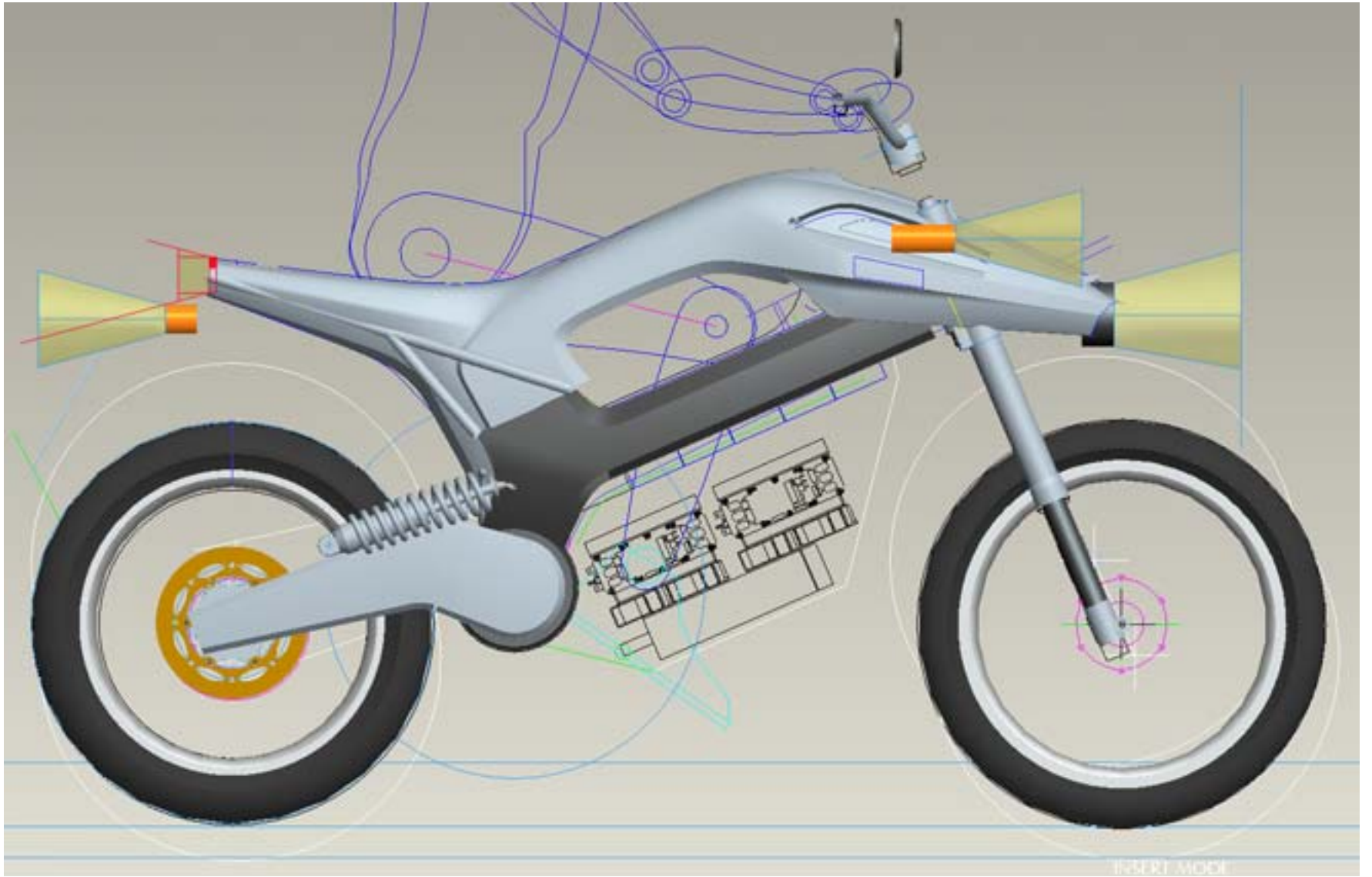
**MOTOR CONTROLLER**

**POWER ELECTRONICS**

















other possibilities on two wheels

# Example of Scooter Installation

## Specification

Hybrid configuration

Intelligent energy power electronics between fuel cell and battery

Fuel cell Intelligent Energy air-cooled

Storage battery 4 x 12V Lead Acid (15Ahr)

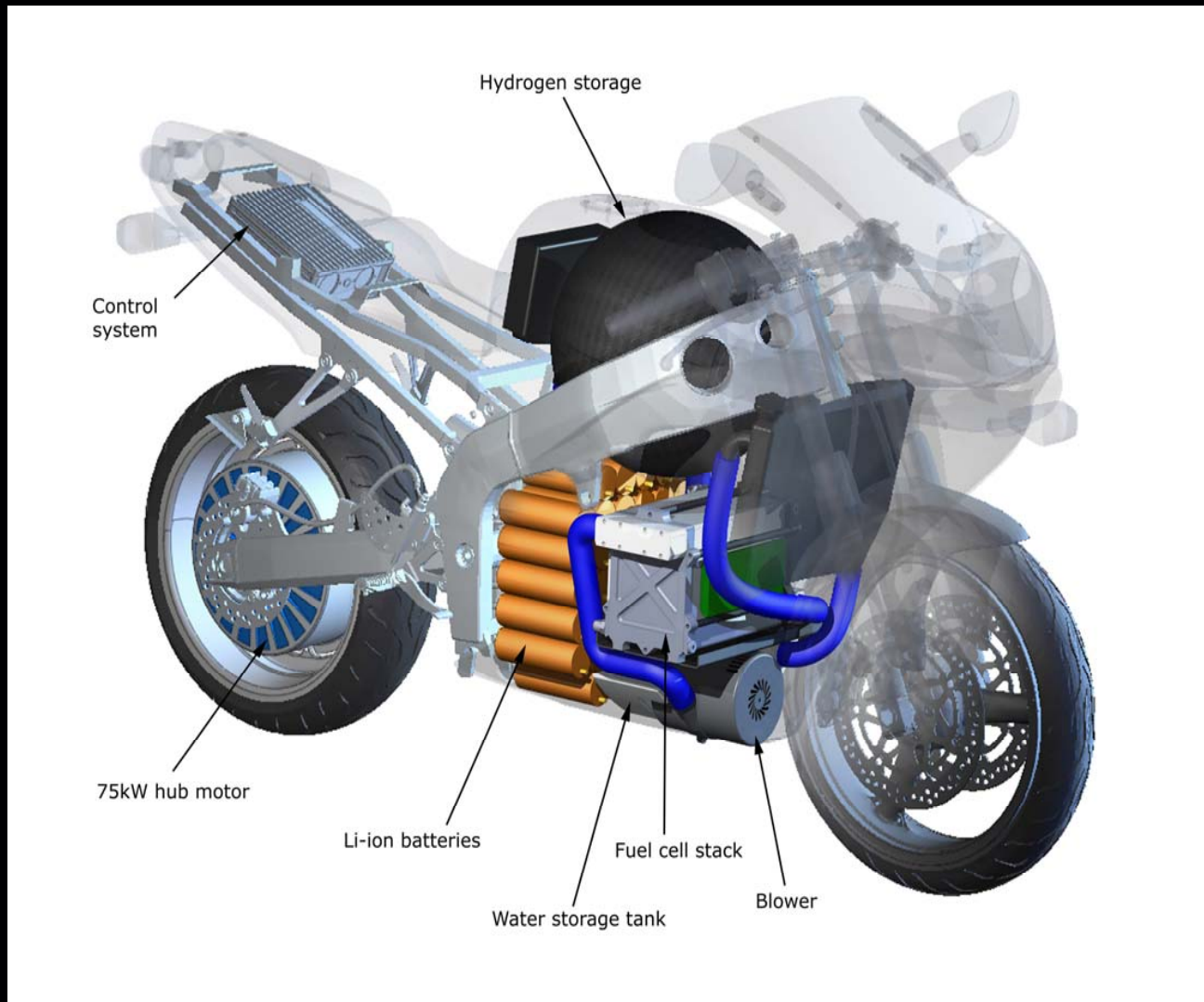
## Fuel

Hydrogen storage High pressure composite cylinder 310 bar (2 x Luxfer L45E). Storage capacity 2540 litres, mass 2 x 2.9kg

Stored energy ~3.3kWeh (electrical output from fuel cell), 0.72kWeh from batteries.



# High Power Fuel Cell Hybrid Concept Bike







Thank you