

# FSB

# 90

## University of Zagreb

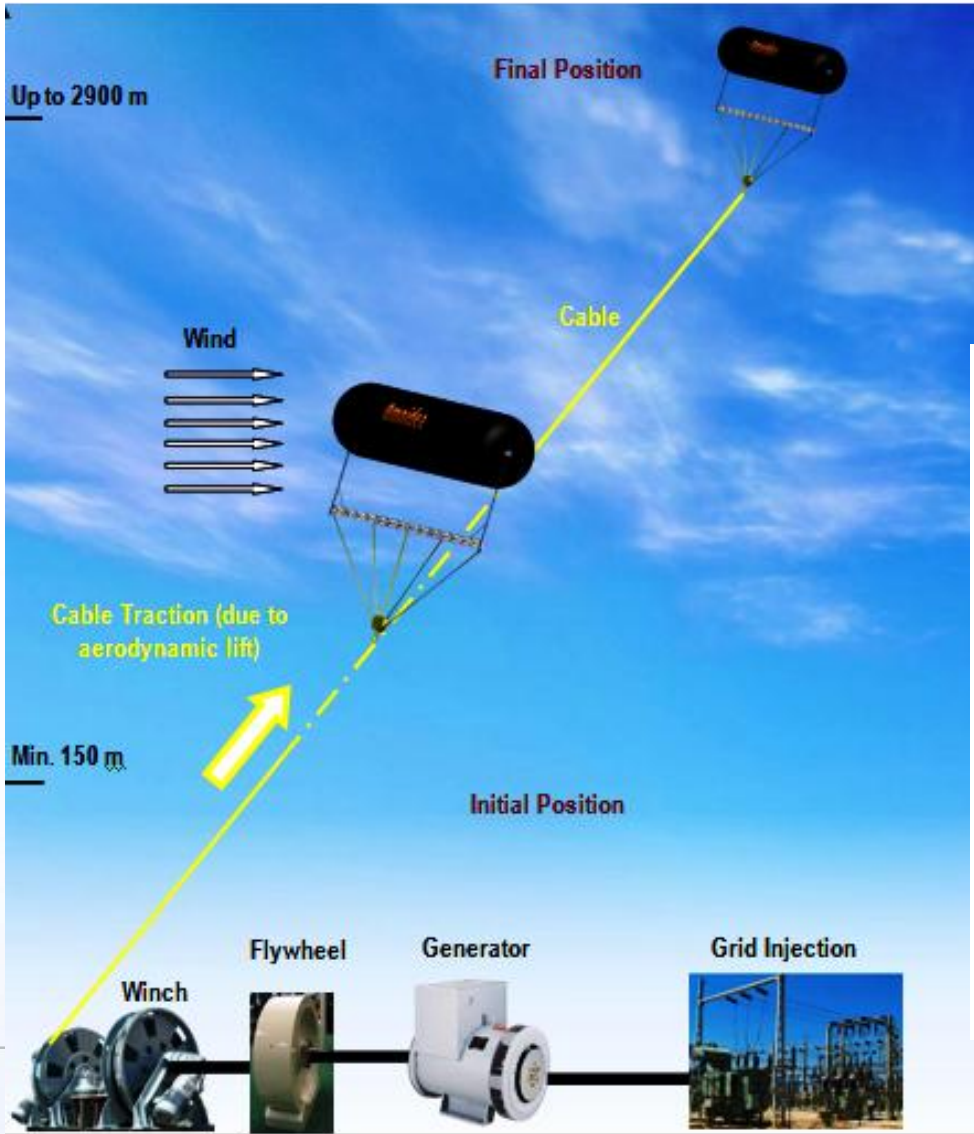
## Faculty of Mechanical Engineering and Naval Architecture

### High altitude wind energy (HAWE)

University of Zagreb  
90 Years of Faculty of Mechanical  
Engineering and Naval Architecture

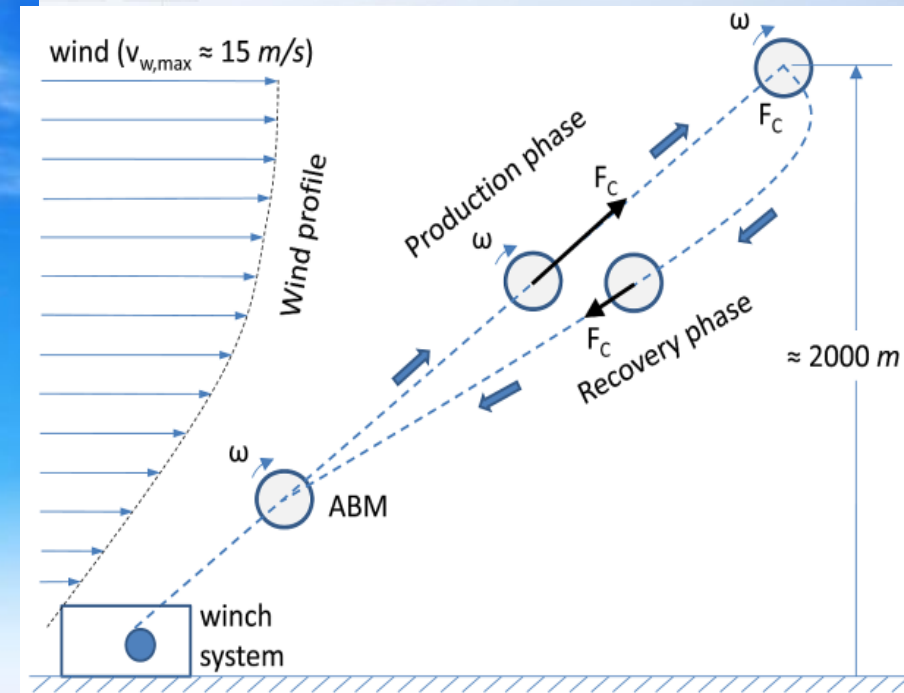


# Overview of HAWE project (1/2)



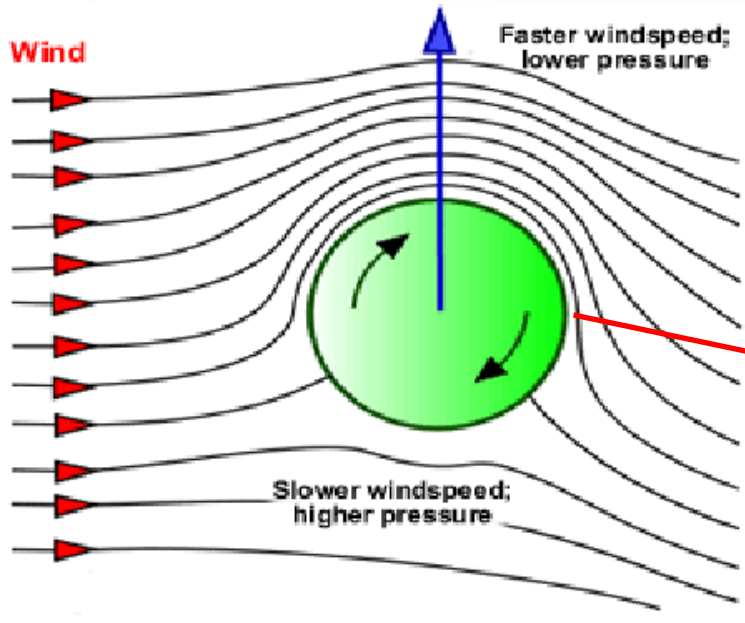
A single cycle is divided into two phases:

- Production phase
- Recovery phase

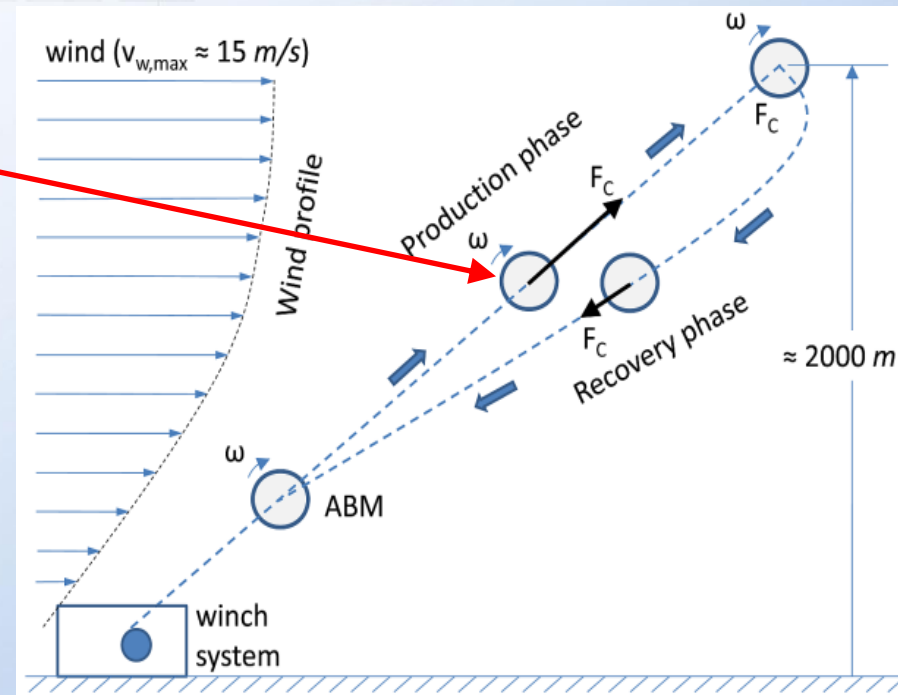


**More info: [omnidea.net/hawe](http://omnidea.net/hawe)**

# Overview of HAWKE project (2/2)



Magnuss' effect creates lift when cylinder is rotated.



More info: [omnidea.net/hawe](http://omnidea.net/hawe)

# UNIZAG FSB team involved in HAWE activities

- University of Zagreb (UNIZAG)
- Faculty of mechanical engineering and naval architecture (FSB-Croatian or FMENA-English)
- FMENA's Laboratory for non-metals  
(*Department of Materials*)
- FMENA's Automotive Mechatronics Group  
(*Department of Robotics and Production System Automation*)
- FMENA's Power Engineering - CFD Group  
(*Department of Energy, Power Engineering and Environment*)

# UNIZAG FSB – overview of WP's contribution

## *WP10 Airborne module research*

WP10.3	Materials selection and Aerodynamic studies
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## *WP20 Airborne module control*

WP20.1	Electromechanical system report
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WP20.2	Modelling and simulation report
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## *WP50 Ground station drive R&D*

WP50.3	Electric Actuation Design & Functional Optimization
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## *WP60 Ground station control*

WP60.1	Ground station configurations and energy storage systems assessment
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WP60.2	Ground station modelling and control
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# WP10.3 – Materials selection

Airborne module - demands:

Inner envelope

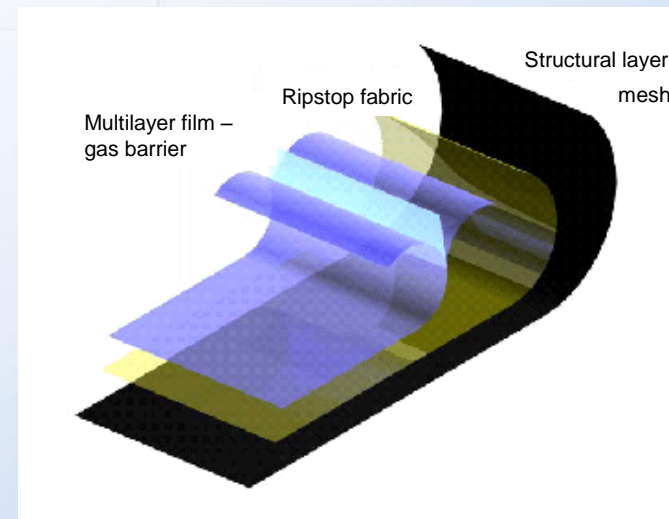
- Gas barrier with good mechanical properties
- Multilayer polymer films
- Seamless and thermally bonded

Outer envelope

- Ripstop fabrics
- Mechanical properties
- UV resistant

Mesh

- UV resistant
- Mechanical properties



Tested 8 inner and 4 outer envelopes, 3 meshes

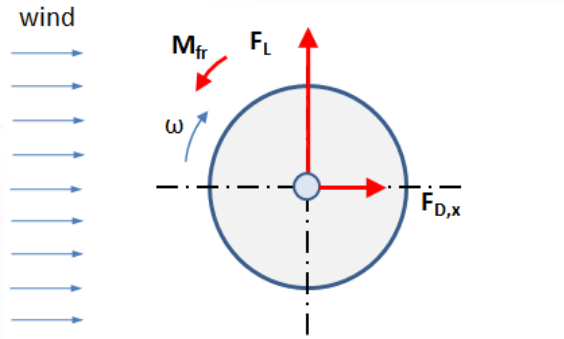
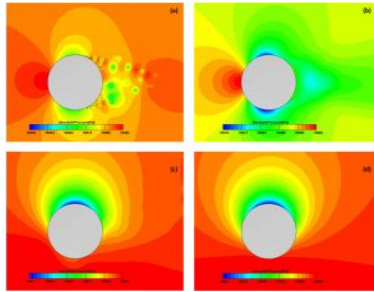
Mechanical tests – tensile, impact and dynamic (DMA) tests

Diffusion – time-lag method, tested with light gases – He, H<sub>2</sub>, N<sub>2</sub>

Weathering – UV and rain cycles

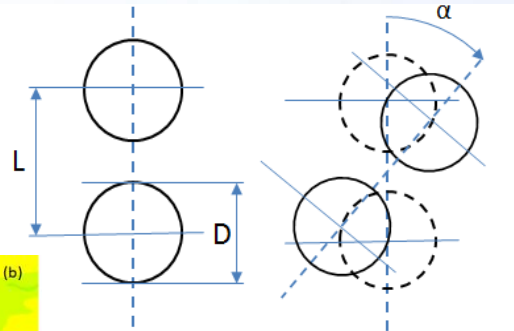
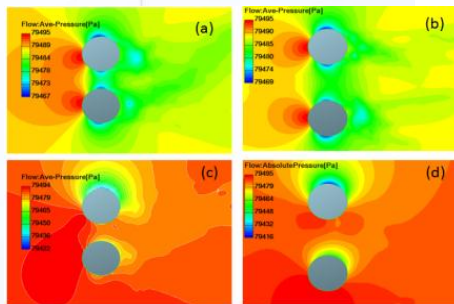
# WP10.3 – Aerodynamic studies (1/2)

- Single cylinder



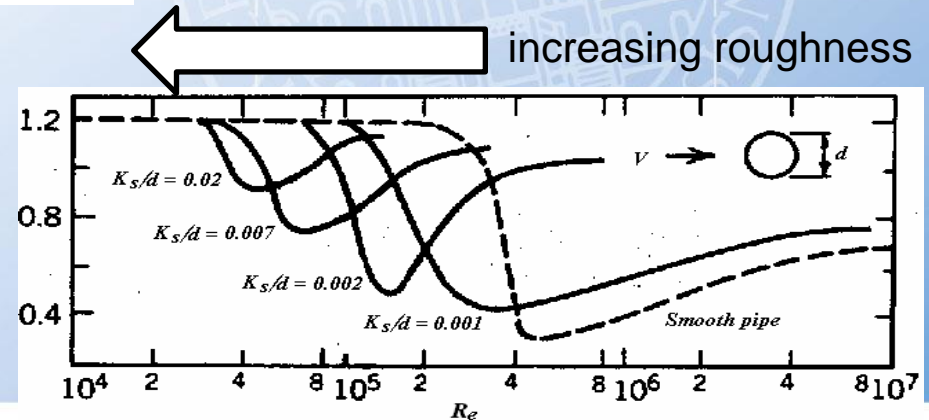
$$C_D, C_L, C_{Mz} = f(\text{Re}, X)$$

- Two cylinders

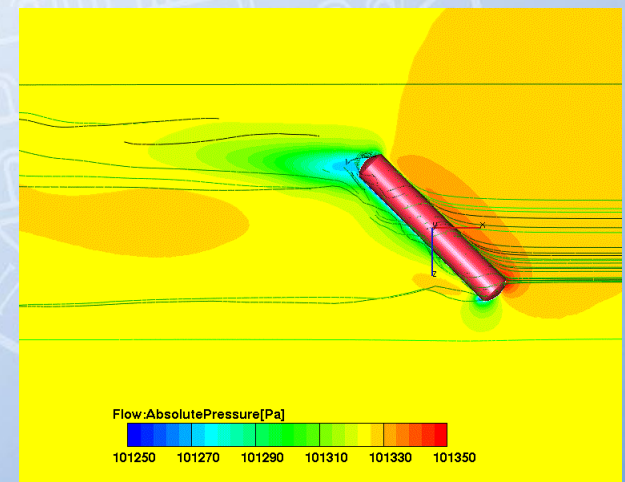
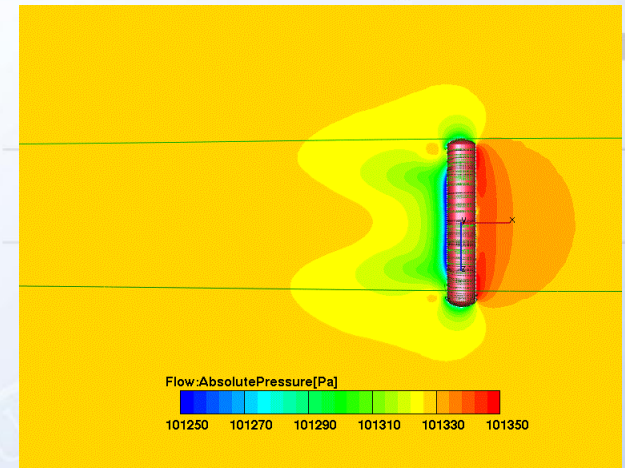
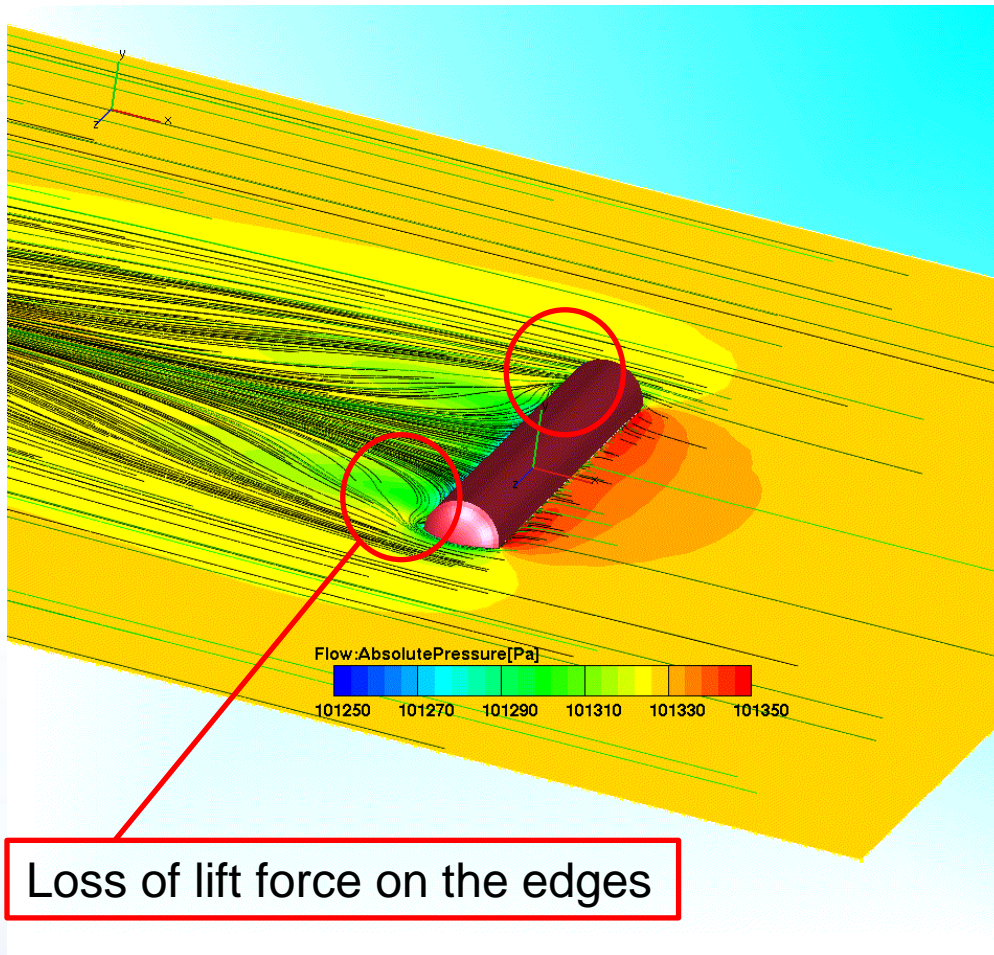


$$C_D, C_L, C_{Mz} = f(\text{Re}, X, L/D, \alpha)$$

- Surface roughness (estimation)



# WP10.3 – Aerodynamic studies (2/2)

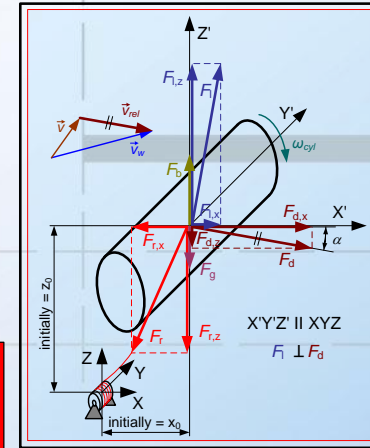
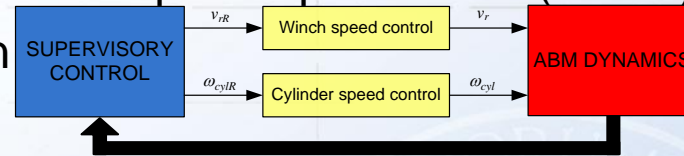




# WP20, WP50 & WP60

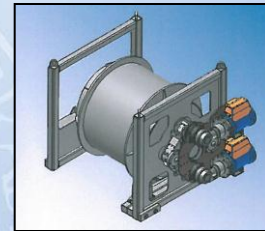
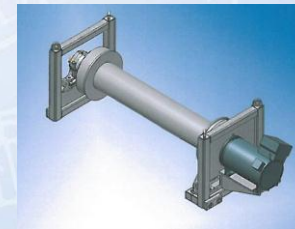
## WP20 – Airborne module control

- Control-oriented ABM dynamics model (D20.1)
- Control variables optimization for max. power production (D20.2)
- Control system design based on optimization results (D20.3)



## WP50 – Ground station drive R&D

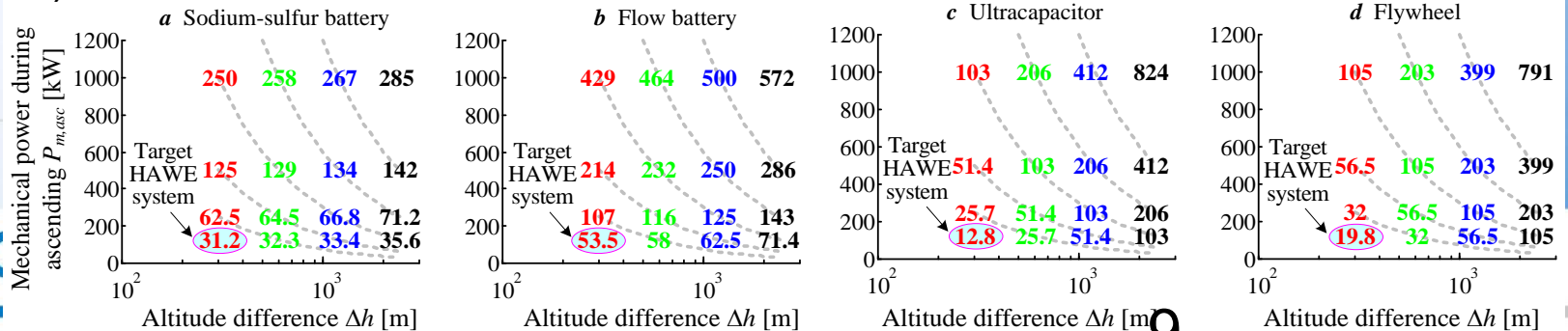
- Assessment of various (direct, geared) winch drive configurations (D50.3.1)



## WP60 – Ground station control

- Design and assessment of various ground station mechatronic configurations with different power transmission and energy storage systems (D60.1)
- Modelling and simulation of proposed mechatronic configurations dynamics (D60.2)

(D60.2) **Energy storage system running costs [ $\times 1000$  EUR] over 1250 days (dashed lines are constant energy curves)**



End slide

Thank You for Your attention

