

PFLICHTENHEFT

LEARNING MODEL ON E-MOBILITY BASED ON COOPERATION

Project: “Learning e-mobility plus”



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0. INTRODUCTION

0.1 BASIC DATA

Intellectual properties	
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0.2 VERSION

Version Information:	
Version	2.0
Authors	<p>Mauro Marzegan (Editing of the document and didactical requirements).</p> <p>Zenone Pegoraro (Technical requirements).</p> <p>Alessandro Scaldaferrò (Quality requirements and final editing).</p>
Date of Creation	1/7/2015
Date of Modification	22/11/2015
Description of the main changes	<p>1.1 Competences to be developed</p> <p>1.2 Initial requirements have been modifying after the meetings with the experts and the company visits.</p> <p>Some technical aspects have been changed because of the students' limited knowledge and the lack of financial resources. The changes applied are aimed at the improvement of the project.</p>

0.3 AIM AND APPLICATION FIELD

The main aim of the following document is to describe the expected tools, the translations of the necessary requisites for an effective and concrete learning of the electrical mobility. This handbook completes the Lastenheft in the same lesson plan and it absorbs the subjects. It highlights the real possibility of fulfillment and the order of priorities.

For each specification the reasons why they are included and how they are intended to realize in the final plan are analyzed in details.

The book is not a handbook for the fulfillment of the teaching act in a technical environment in the vocational education on the topic of the electrical mobility.

The book is a set of guidelines to create the best scenery in a learning environment. It's useful to the development of the subjects. For this reason, this handbook is flexible to be used in various situations in the vocational education in accordance with the defined requisites.

This handbook was chosen to be an example for the Quality Management of the Authority which wants to achieve thanks to a master. It indicates phases, times and responsibility.

0.4 ACRONYMS AND ABBREVIATIONS

For a quickly comparison with the Lastenheft, it is necessary to keep the same terminology.

MODEL 1E	ELECTRICAL CONVERTED MODEL
MODEL 2H	HYBRID CONVERTED MODEL (IN SERIES)
RD	DIDACTICAL-EDUCATIONAL REQUIREMENT
RT	TECHNICAL REQUIREMENT
RF	FUNCTIONAL REQUIREMENT
RP	PERFORMANCE REQUIREMENT
RQ	QUALITY REQUIREMENT
RA	ADDITIONAL REQUIREMENT

0.5 DOCUMENT STRUCTURE

The document is divided into different sections in order to be easily used.

Section 1 (Chapter from 1): it has got the instructions for the achievements of different outputs. The main phases are indicated to be followed but they are flexible to meet specific demands of the didactic work.

This section is built up with easy tables for consultation. The times are indicated but they are useful to skip a waste of resource.

Section 2 (from chapter 2 to 5): in this section there is the analysis of the instructions which were indicated on the Lastenheft. The same plan is kept so the two sections can be compared.

The analysis of each requisite can accept many requests and give details of the method for the translation of a requisite.

For each activity specified on the following handbook, a master is built up in a scheme:

COMPETENCE	
FINAL ACTIVITIES MANAGER	
ACHIEVEMENT MANAGER	
EXPECTED TIMES	
ADDITIONAL FIGURES	
FINAL OUTCOME	

1. **Competence**: Knowledge to impart during the activity. each output is important to learn knowledge connected with electrical mobility. Cross or basic knowledge are not indicated on the table. Since they are essential they are also in the first section of the handbook where it's possible to find the instructions for each output.
2. **Final Activities Manager**: for each aspect a manager must be indicated. He should check the activities out.
3. **Activities Manager**: he should be clearly indicated and mentioned for the real achievement of the activities.
4. **Expected times for the activities**: they must be mentioned because the master is the output of many actions and their synchronization is necessary to be repeated in

future. These times can vary in order to meet different demands, face possible problems, give any clarification the users can consider important to be cleared.

5. **Possible additional figures:** on this section possible consultants must be indicated because they are important for the achievement of the activities.
6. **Final output:** it indicates how the final output of the activities is presented.

On the document people and outputs are generically indicated but the person who is going to do some activities must explain people and times involved (the beginning and the end).

For the analysis of the single requisite the previous document (Lastenheft) is to be followed adding some columns to see how each requisite has been analyzed.

REQUISITE CODE/ STARTING REQUISITE/JUDGEMENT

REQUISITE/PRIORITY/ANALYSIS OF THE REQUISITE AND ITS DEVELOPMENT / MANAGER REQUISITE

CODE	REQUIREMENT	REQUIREMENT EVALUATION	PRIORITY LEVEL	REQUIREMENT DEFINITION AND APPLICATION	REQUIREMENT SUPERVISOR
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REQUIREMENT EVALUATION: the requisite can be meant POSSIBLE or IMPOSSIBLE.

The most important elements to analyze the real achievement of the requisite come from:

- Final addressees of the lesson plan and general targets
- Economic resources and equipment
- Human resources and real knowledge

In case of impossible requisite, the reasons why the requisites can't be accepted must be described.

PRIORITY LEVEL: In case of a possible requisite, priority can be high, medium, low.

- HIGH: It's essential for a positive outcome of the learning plan. Therefore it's important to pay attention not to void the outcome and the activities.

- AVERAGE: it's a possible requisite to change in case of technical problems or excessive request of resources. If a requisite is not respected, the reasons must be explained with details of the changes.
- LOW: it's connected with a requisite to get, but it's not essential for the positive outcome for the learning plan. In case of problems the requisite can be cancelled or not respected. For the reduced effect on the learning plan the details of the modifications are not requested.

REQUIREMENT DEFINITION AND APPLICATION: It describes the instructions to achieve the requisite in the learning plan highlighting the times and the stages.

REQUIREMENT RESPONSIBILITY: He is responsible for the final check, the respect of the instructions and the achievement of the requisite.

SECTION 1

EXPECTED OUTPUTS AND BASIC INSTRUCTIONS

- 1.1 INSTRUCTIONS FOR THE REALIZATION OF TWO HYBRID KARTS**

- 1.2 INSTRUCTIONS FOR THE REALIZATION OF EDUCATIONAL MATERIAL ABOUT SAFETY**

- 1.3 INSTRUCTIONS FOR THE REALIZATION OF EDUCATIONAL MATERIAL ABOUT ELECTRIC TECHNOLOGY**

- 1.4 INSTRUCTIONS FOR THE REALIZATION OF TESTING ACTIVITIES**

- 1.5 ACTIVITY FLOW CHART**

1.1 INSTRUCTIONS FOR THE REALIZATION OF TWO HYBRID KARTS

Skills to reach:

- Elementary efficiency of an electrical and hybrid system in resulting from the ability to understand the principles of operation and technology applied
- Define and plan the necessary operations on the basis of instructions received related to the project
- Prepare the tools and the equipment needed on the basis of the project, the type of materials to be used and the expected result
- Monitor the tools, the equipment and the machinery and verify their routine maintenance
- Prepare and clean the workspaces in order to ensure compliance with the rules of hygiene and hinder fatigue and occupational diseases
- Operate according to the quality criteria set by the company protocol, recognizing and understanding the needs of the internal/external customer/user
- Operate safely and in compliance with the rules of hygiene and environmental protection, identifying and preventing dangerous situations for themselves, others and the environment
- Prepare and assemble the Karts and its various components, in compliance with the safety standards, the design specifications and the technical sheets
- Test the karts in accordance with the design specifications
- Identify critical issues and possible areas of intervention for the restoration of the functionality
- Problem solving
- Routine and emergency maintenance, identify any anomalies and malfunctions

For the implementation 30 hours of work have been estimated to be divided into the following stages.

FASES	DESCRIPTION	ESTIMATED TIME
1	Work Planning Instruments and tools set-up Definition of check points	2 hours
2	Workspaces arrangement	
3	Making of the support for the kart	1 hour
4	Positioning of the karts following concepts of stability, moving and working easiness	1 hour
5	Remove the engine from the kart	3 hours
6	Remove all the unnecessary parts	3 hours
7	Installation of the thermic engine and components adaptation	3 hours
8	Installation of the electric engine and components adaptation	4 hours
9	Installation of battery pack	2 hours
10	Mechanical functioning test	2 hours
11	Electrical functioning test	2 hours
12	Required adjustments	1 hour
13	Testing	1 hour
14	Failure scouting	2 hours
15	Failure repair	2 hours
16	Substitution of defective components	1 hour
		30

The timing and the steps provided are indicative and may change on the basis of any technical problems or considerations that may arise during the realization.

The two carts may be built separately or in combination; in case of unique building, the estimated time have to be considered lower because some activities have already been implemented and do not need to be replicated.

1.2 INSTRUCTIONS FOR THE REALIZATION OF EDUCATIONAL MATERIAL ABOUT SAFETY

Competences to be acquired:

- Respect the safety rules in force, with particular reference to the risks associated with technologies applied on electric and hybrid vehicles
- Prepare the workspaces in order to ensure compliance with the rules of hygiene and to hinder fatigue and occupational diseases
- Operate safely and in compliance with the rules of hygiene and environmental protection, identifying and preventing dangerous situations for themselves and the others

STAGES	DESCRIPTION	ESTIMATED HOURS
1	Define the content to be included in the handout	1 hour
2	Verify the material used in training courses	1 hour
3	Look for new material, legislative updates and contents	8 hours
4	Choose the format	20 hours
5	Write the handout	
6	Control and verify	3 hours
		33 hour

As regards the educational material, innovative tools and methodologies must be privileged, according to their availability, in order to increase the interest towards the topics.

The number of hours given is approximate and to be taken into account only to facilitate the planning of the activities; obviously they can be changed according to the different needs of the managing authority.

1.3 INSTRUCTIONS FOR THE REALIZATION OF EDUCATIONAL MATERIAL ABOUT ELECTRIC TECHNOLOGY

Competences to be acquired:

- Recognize the principles of auto mechanics technology
- Recognize the principles of electrical technology
- Recognizing the differences in terms of technology between hybrid systems (in series and in parallel)
- Recognize the main components of a hybrid engine and their characteristics.

STAGES	DESCRIPTION	ESTIMATED TIME
1	Recognize the principles of auto mechanics technology	2
2	Recognize the principles of electrical technology	2
3	Recognizing the differences in terms of technology between hybrid systems (in series and in parallel)	4
4	Recognize the main components of a hybrid engine and their characteristics.	2
5	Recognize the main components of the electrical system of the two engines	2
		12

The handout and the educational material should be practical, fast and easy to use, as well as the information included and the format.

The number of hours given is approximate. The educational materials of the two systems – in series and in parallel – can be developed simultaneously or sequentially.

1.4 INSTRUCTIONS FOR THE REALIZATION OF TESTING ACTIVITIES

Competences to be acquired:

- Analytical: ability to carry out evaluation on the basis of some indicators given
- Communicative: ability to present analysis results in a clear and effective way

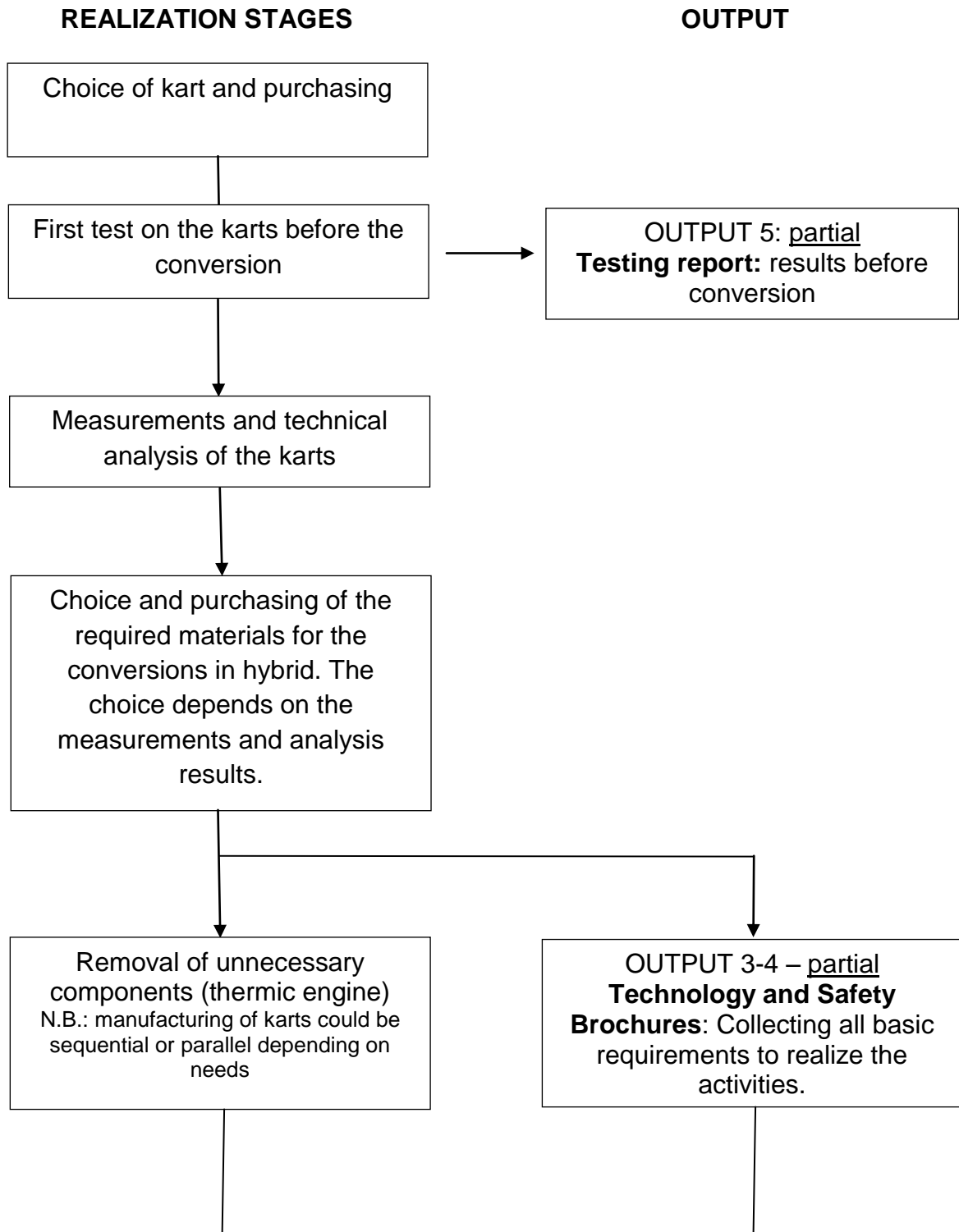
STAGES	DESCRIPTION	ESTIMATED TIME
1	<u>Initial evaluation</u> : Definition of tests to be carried out, research of structures and materials for the realization of the tests	3 hours in totale
2	<u>Initial evaluation</u> : Review of tests to be performed and any modifications	
3	Initial tests, data collection and suggestions for possible modifications	
4	<u>Final evaluation</u> : Definition of tests to be carried out, research of structures and materials for the realization of the tests	4 hours in totale
5	<u>Final evaluation</u> : Review of tests and determination of any modifications	
6	Final tests before processing, data collection and suggestions for possible modifications	
7	Report for the presentation of the data	3 hours
		10 hours

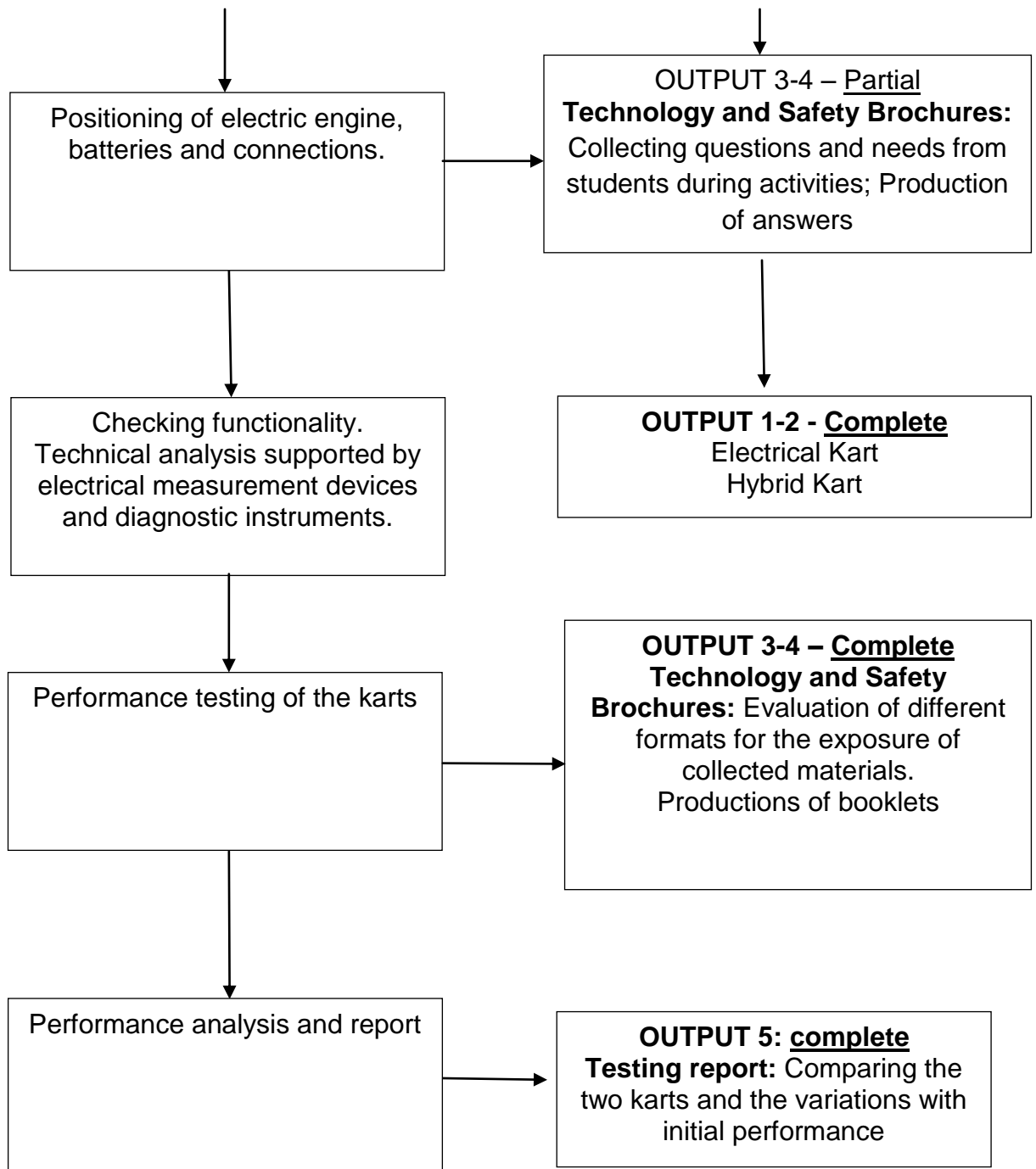
The tests' main objective is that of providing skills to be employed by the workers in the processes of research and development. Testing skills and reporting methodologies can be exploited even in companies where the quality management system is well implemented.

The evaluation and the comparison of performance introduce the target groups and other stakeholders to the benefits that the electrical technology involves: reduced consumption and reduction of costs (economic) and reduction of emissions and noise (environmental).

1.5 ACTIVITIES FLOW CHART

This Flow chart describes general guidelines and stages to realize the expected outputs according to project requirements





SECTION 2

Requirements evaluation analysis

2. TECHNICAL AND FUNCTIONAL REQUIREMENT EVALUATION

2.1 NECESSARY REQUIREMENTS

2.2 SECONDARY REQUIREMENTS

2.3 TECHNICAL REQUIREMENTS

3. REQUIREMENTS ANALYSIS: PERFORMANCE REQUIREMENTS

4. REQUIREMENTS ANALYSIS: QUALITY REQUIREMENTS

5. REQUIREMENTS ANALYSIS: OTHER REQUIREMENTS

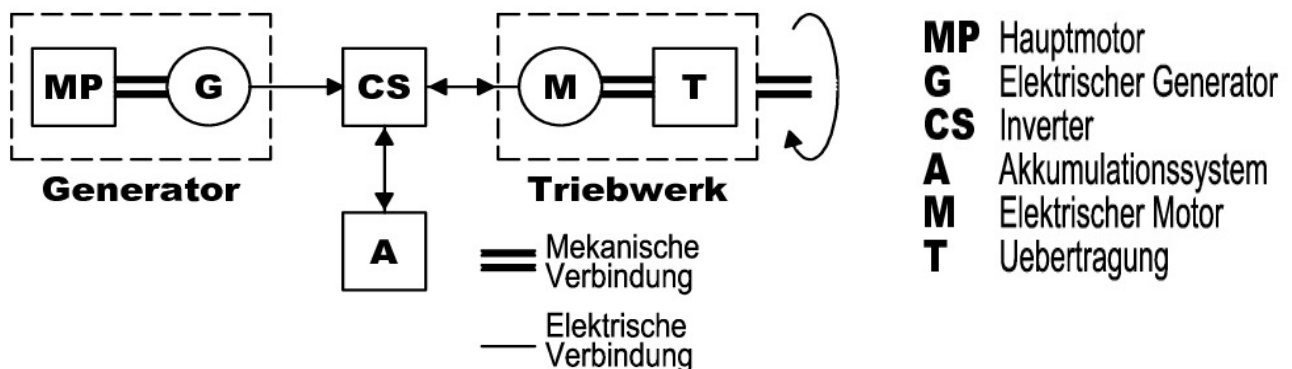
2. TECHNICAL AND FUNCTIONAL REQUIREMENT EVALUATION

2.1 NECESSARY REQUIREMENTS

KART 1 – Series connected engines

TARGET SKILLS	<p>Basic executory skills on an electrical kart, acquired through the correct understanding of working concepts and technology basis.</p> <p>Basic abilities on finding weak points of the system and setting strategies to restore functionality.</p> <p>Problem solving skills</p>
ACCOUNTABLE	Laboratory trainer/teacher
DEVELOPERS	Students
TIME NEEDED	6 full days (48 hours)
ADDITIONAL SUBJECT INVOLVED	<p>Support and advices from enterprises involved in automotive field and in e-mobility.</p> <p>Contribution from technical teachers.</p>
FINAL OUTPUT	A hybrid kart with two engines connected in series.

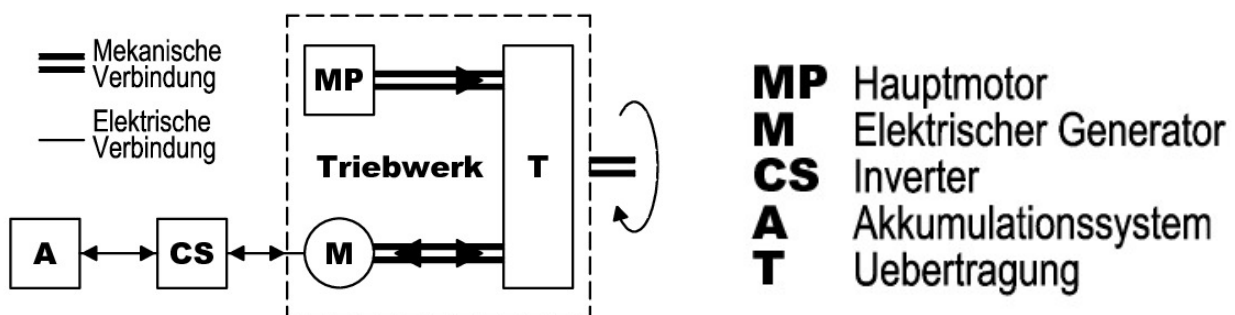
Basic connection scheme



KART 2 – Parallel connected engines

TARGET SKILLS	<p>Basic executory skills on a parallel hybrid system, acquired through the correct understanding of working concepts and technology basis.</p> <p>Basic abilities on finding weak points of the system and setting strategies to restore functionality.</p> <p>Problem solving skills</p>
ACCOUNTABLE	Laboratory trainer/teacher
DEVELOPERS	Students
TIME NEEDED	6 full days (48 hours)
ADDITIONAL SUBJECT INVOLVED	<p>Support and advices from enterprises involved in automotive field and in e-mobility.</p> <p>Contribution from technical teachers.</p>
FINAL OUTPUT	A kart with two engines – one electrical and one with heating system – connected in series.

Basic connection scheme



CODE	REQUIREMENT	REQUIREMENT EVALUATION	PRIORITY LEVEL	REQUIREMENT DEFINITION AND APPLICATION	REQUIREMENT SUPERVISOR
<u>Technical requirements of the two karts:</u>					
RT0001	Both the karts must be initially with heat engines, and later converted to electric and hybrid traction.	REALIZABLE	MEDIUM	When buying the individual in charge will verify that the two karts are equipped with heat engines.	Laboratory teacher
RT0002	The hybrid model must operate in full hybrid, that is, it must be able to operate in pure electric if required.	REALIZABLE	MEDIUM	When buying the individual in charge will verify that all materials are functional to the realization of "full hybrid" karts.	Laboratory teacher
RT0003	It should not use an intensity of power dangerous to humans (the voltage must be less than 50 V). If it's possible to REPLICARE higher intensity in accordance with the terms of the budget, similar to what is seen on vehicles in circulation, particular attention must be paid to the Safety module and to the use of planned PPE.	REALIZABLE	HIGH	The end-user security must be one of the main priorities of the project. The recipients are apprentices or students of vocational training, so they could be between 16 and 18 years old. Therefore, the legislation must also consider the additional rules that concern workers of this age group.	Laboratory teacher
RT0004	The two karts must be realized with a budget of € 10,000 or less.	REALIZABLE	HIGH	For the purchase of the kart must be used the 20% of the budget, possibly by purchasing second-hand products, in order to preserve the	Director of the Institution that realizes the training course

				main part of the budget to buy materials used in the creation of the hybrid system.	
RT0005	The karts must be easily transportable.	REALIZABLE	HIGH	The support used to build the karts during the working phase is also expected to be able to easily transport them, with the aim to publicize the project and the obtained results too.	Laboratory teacher
RT0006	The two karts must have the same frame size.	REALIZABLE	LOW	The two karts will be purchased of the same model so they will have the same frame size.	Laboratory teacher
RT0007	Before processing the two karts must have the same weight.	REALIZABLE	AVERAGE	The two karts will be purchased of the same model so they will have the same weight.	Laboratory teacher
RT0008	On the two models should be simple to simulate both mechanical and electrical faults to be used for exercises.	REALIZABLE	AVERAGE	The realization of the karts and the construction of the course material should run in parallel, in order to identify the technological characteristics of the materials used and to define the fault simulation exercises, both practical and theoretical.	Laboratory teacher
RT0009	The two models must be convertible to the initial state and the materials must be reusable in order to achieve the same type of project with	REALIZABLE	AVERAGE	In the initial phase of dismantling maximum attention must be dedicated to the elimination of the single components without damage, in order to have the possibility of	Laboratory teacher

	different groups of students.			reuse the same materials. Relevant steps both of dismantling and of construction must be recorded.	
RT0010	The two different hybrid models should be clearly visible and interpretable by anyone wishing to view the models.	REALIZABLE	AVERAGE	A specific operation scheme, with the connection diagram of each of the two different types of connection, must be positioned on each kart carriage. Each kart will then be assigned an identification number (1 for the kart with series connection; 2 for the kart with parallel connection). Each document or specific instrument of one of the two karts will have the same code clearly visible in order to be immediately identifiable by each user, also external.	Laboratory teacher
RT0011	The models must comply with the safety measures and in general with the requirements of current legislation.	REALIZABLE	AVERAGE	During dismantling, before proceeding with the construction of the hybrid system, we will collect the necessary information about the legislative and regulatory requirements, both through a direct search of information by the teachers, and in the first phase of cooperation provided by the companies. The results of this phase will then become important in	Laboratory teacher

				the realization of the accompanying documents and they will have to be made every time this training module will be repeated, in order to check for any changes that may occur.	
RT0012	The models must respect appropriate principles of aerodynamics and stability in order to don't be dangerous and to provide performances in compliance with those obtained before processing.	REALIZABLE	HIGH	During the assembling phase the utmost attention must be paid in maintaining the same aerodynamic characteristics and the original karts stability in order to ensure proper load balancing for driving safety. The relevant construction phases must be recorded.	Laboratory teacher
RT0013	At the end of the process the two karts must have similar weight, with a maximum allowable difference of 5%	REALIZABLE	AVERAGE	The karts must have a weight similar to the original to ensure the proper balancing of the loads for the driving safety.	Laboratory teacher
RT0014	Two evaluate sessions must be provided, an intermediate one and a final one, by one or more representatives of companies working in the field of electromobility, both to correct any defects of the two models and as a motivational moment for students of vocational training.	REALIZABLE	AVERAGE	The ongoing and final evaluation must ensure functionality, compliance with the regulations, stability, security and fidelity to the original project. The control process is intended to recommend the changes to be made on the karts to respect these principles.	Laboratory teacher; qualified technician of one of the companies involved.

<u>Technical requirements of the endothermic engine:</u>					
RT0013	Four-stroke engines will be used because, although they are heavier and have less power, offer less polluting emissions and lower specific fuel consumption.	REALIZABLE	AVERAGE	During realization 4-stroke engines will be used with the aim of reducing polluting emissions, the operating costs and, at the same time, increasing the reliability: these engines have long been incorporated in the karting world, replacing the 2-stroke engines, to attract more people.	Laboratory teacher
RT0014	There must be a air cooling to have more room available by removing the radiator.	REALIZABLE	AVERAGE	The air cooling is enough to the karts engine to reduce the operating temperature, expected in any case limited; moreover, it needs less maintenance, increasing the space available to make the foreseen changes.	Laboratory teacher
RT0015	It must be an electric starter engine.	REALIZABILE	AVERAGE	The electric starter allows an easier use of the kart: they are vehicles not suitable for motor racing, so it's possible to exclude the mechanical starter.	Laboratory teacher
RT0016	There must be a battery charging system.	REALIZABLE	AVERAGE	The batteries will be recharged by e-station. With the current lithium batteries, it is also possible to make partial recharges during the day or full and slow charges that allow low absorption of KW / h.	Laboratory teacher

<u>Technical requirements of the electric engine:</u>					
RT0017	The power expressed before processing must be the same for both models.	REALIZABLE	AVERAGE	It's necessary to maintain the original power to enable a correct comparison of fuel consumption and emissions.	Laboratory teacher
RT0018	The final power to the wheel must be of equal value for both models.	REALIZABILE	AVERAGE	It's necessary to maintain the same power to enable a correct comparison of fuel consumption and emissions.	Laboratory teacher
<u>1E MODEL (electric) specific requirement</u>					
RT0020	The 1E Model must be realized converting a vehicle from traditional to electric traction.	REALIZZABILE	ALTA	The realization of a purely electric kart is an improvement of the training course enabled by the project and doesn't change substantially from the concept of hybrid expected in the previous version of the document, with the heat engine as source for recharging the batteries for the electric one. From the point of view of the accompanying training modules and of the practical activities, both of study and diagnostic, changes were not necessary.	Formatore di laboratorio
RT0021	The 1E Model must have an engine power of 6 HP or more with a torque of around	REALIZABLE	HIGH	The machine torque is the mechanical moment applied by the motor to the transmission that	Laboratory teacher

	3500 rpm.			determine the acceleration and the speed of the kart.	
RT0022	The 1E MODEL must have an electric engine power exceeding 9 kW. in direct current with a potential of less than 50 volts.	REALIZABLE	HIGH	It must be maintained the original kart's power of 9 kW. The voltage must be below 50 volts because it's deemed not dangerous to humans by the safety regulation. Exceeding this threshold can only happen with appropriate modifications in relation to safety material product and used by students.	Laboratory teacher
RT0023	Before the realization of the conversion for the 1E model, a test battery must be provided to verify the initial consumption.	REALIZABLE	HIGH	Consumption have to be verified with the initial endothermic engine to allow a comparison with the final results.	Laboratory teacher
RT0024	Before the realization of the conversion for the 1E model, a test battery must be provided to verify the initial CO2 emissions.	REALIZABLE	HIGH	Emissions have to be verified with the initial endothermic engine to allow a comparison with the final results.	Laboratory teacher
<u>2H Model (Hybrid) specific requirement</u>					
RT0050	The 2H model must provide a hybrid series connection between a heat and an electric engine.	REALIZABLE	HIGH	It was not possible to realize a hybrid model with parallel connection because of the high costs and skills came to light under construction, especially as regards	Laboratory teacher

				the software that allows to coordinate the number of rpm. However, it is provided a hybrid model with the purely didactic purpose to analyze connections and basic diagnostic activities.	
RT0051	The 2H model must have an engine power of 12 HP or more with a torque of around 3500 rpm	REALIZABLE	HIGH	The machine torque is the mechanical moment applied by the motor to the transmission that determine the acceleration and the speed of the kart. The 12 HP and the 3500 torque rpm, in the hybrid parallel engine, allow a 9 Kw power output.	Laboratory teacher
RT0052	The 2H MODEL must have an electric engine power exceeding 9 kW in direct current with a potential of less than 50 volts. In any case the two engines must be the same in order to obtain a final power to the wheel of equal value.	REALIZABLE	HIGH	It must be maintained the original kart's power of 9 kW. The voltage must be below 50 volts because it's deemed not dangerous to humans by the safety regulation. Exceeding this threshold can only happen with appropriate modifications in relation to safety material product and used by students.	Formatore di laboratorio
RT0053	Before the realization of the conversion for the 2H model, a test battery must be provided to verify the initial consumption.	REALIZABLE	HIGH	Consumption have to be verified with the initial endothermic engine to allow a comparison with the final results.	Laboratory teacher

RT0054	Before the realization of the conversion for the 2H model, a test battery must be provided to verify the initial CO2 emissions.	REALIZABLE	HIGH	Emissions have to be verified with the initial endothermic engine to allow a comparison with the final results.	Laboratory teacher
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EDUCATIONAL MATERIAL REALIZATION

TARGET SKILLS	<ul style="list-style-type: none"> - Student have to understand the functional and technological differences between series and parallel connection systems. - Students have to recognize the main components of hybrid system and their characteristics. - Student must approach on working process according to safety and quality standards, being familiar particularly whit specific risks connected with e-mobility technology.
ACCOUNTABLE	Technology teacher
DEVELOPERS	Technology and science teachers
TIME NEEDED	15 days to develop both booklets
ADDITIONAL SUBJECT INVOLVED	Support and advices from enterprises involved in automotive and e-mobility field. Cooperation with teacher of different fields of study (f.e. safety teachers)
RISULTATO FINALE	Two booklets about technology, safety and risk prevention.

CODE	REQUIREMENT	REQUIREMENT EVALUATION	PRIORITY LEVEL	REQUIREMENT DEFINITION AND APPLICATION	REQUIREMENT SUPERVISOR
RD0001	The transformation into a hybrid kart must entirely be made by students.	REALIZABLE	HIGH	For the analysis of problems, the teacher will lead the discussion with the entire group of students of the course; the activities will be conducted by small groups of 5-8 students under the supervision of the trainer.	Laboratory teacher
RD0002	A module on electrical technology containing instructions on security, the characteristics of both the batteries and the electrical motors.	REALIZABLE	HIGH	A didactic module on electrical security according to previous indications is foreseen. It is recommended to involve students in the creation of the documents. For the didactic material more specific requirements are requested to improve the quality and effectiveness of the material produced.	Technology teacher
RD0003	Search for information and personal reflection on the two technologies used.	REALIZABLE	HIGH	At least two moments of formal analysis will be set to evaluate the materials used, the technical decisions and the technologies developed: 7. at the end of the transformation phase into hybrid	Technology teacher

				<p>8. after the tests, evaluating the results obtained to integrate the previous analysis.</p> <p>In case new problems arise, other informal moments are foreseen under the guidance of the trainer and with the consultation of the companies' staff.</p>	
RD0004	Brainstorming and problem solving.	REALIZABLE	MEDIUM	<p>The moments of brainstorming and problem solving will arise automatically. Laboratory and technology teachers will lead students to the best solutions, allowing them sometimes to make mistakes and correct them too. The solutions found will also be discussion topics during the meetings with representatives of the world of work and in companies.</p>	<p>Laboratory teacher Technology teacher</p>
RD0005	Sizing of components ("battery pack", propulsion units, drive wheel ...).	<p>NOT REALIZABLE:</p> <p>The complexity of calculation doesn't fit the characteristics of vocational training. Most likely these theme is a priority in higher level courses.</p> <p>Considering the recipients of the didactic actions, we could risk a</p>			

		loss of affection on the subject of E-mobility. Specific formulas could be used but non necessary studied by trainees			
RD0006	Technical design of electromechanical devices.	NOT REALIZABLE: Technical design supported by CAD, PLC and other software is important to understand the technology applied, but it could be hard to schedule this activity in the planning. This skill should already be provided during regular training activities of regular courses			
RD0007	During the phase of control and verification, measurement tests of the electrical quantities must be provided.	REALIZABLE	MEDIUM	It is necessary to monitor voltage and current consumption because the required parameters can be observed.	Laboratory teacher
RD0008	During the control and verification phase, proofs of testing and analysis of the proper operation of the mechanical parts of autonomy in "pure electric" and of re-charging on board must be provided.	REALIZABLE	HIGH	The evidence of the analysis provided are necessary because, as the law requires, the security of the means must be maintained to avoid a structural and mechanical breakup and, at the same time, to reach its target (independence and functioning in "pure electric").	Laboratory teacher
RD0009	During the testing phase, it should be planned an	REALIZABLE	MEDIUM	A procedure for failure and anomalies analysis must be	Laboratory

	investigation of anomalies and failures of the electrical and mechanical apparatus.			provided for proper and effective maintenance of the mechanical and electrical equipment.	teacher
RD0010	During the testing phase, the maintenance of any faults must be provided.	REALIZABLE	MEDIUM	A procedure must be provided for proper and effective maintenance of mechanical and electrical equipment breakdowns.	Laboratory teacher
RD0011	During the testing phase, there must be control of CO2 emissions.	REALIZABLE	HIGH	The emissions must necessarily be verified to compare the data obtained by the initial endothermic engine.	Laboratory teacher
RD0012	During the testing phase, the control of the dissipation of energy must be provided.	REALIZABLE	HIGH	The dissipation of energy must necessarily be verified to compare the data obtained by the initial endothermic engine.	Laboratory teacher
RD0013	In support of the implementation process, a safety handout should be made.	REALIZABLE	HIGH	It is necessary to provide a complete safety handout, with the aim of eliminating and, where not possible, of reducing the risks and dangers of injury from electrical, chemical and mechanical damage.	Technology teacher
RD0014	In support of the implementation process it should be made a technology handout relating to hybrid engines.	REALIZABLE	HIGH	The theoretical support, while necessary, must be easy to use so that also students with minimum requirements can access to such training.	Technology teacher
RD0015	The technology handout must contain brief details	REALIZABLE	MEDIUM	Where necessary, exemplary tables must be prepared where to	Technology teacher

	about physical, chemical and mathematical prerequisites considered necessary for proper operation of hybrid vehicles.			collect the technical data of the kart.	
RD0016	The technology handout must contain a section for all the necessary mathematics formulas.	REALIZABLE	LOW	Some formulas are necessary, for example in the case of electrical magnitudes where the evidence of indirect measures involve the calculation of the magnitude itself.	Technology teacher
RD0017	Handouts must be used separately, so they must be divided.	REALIZABLE	LOW	Handouts should be divided to facilitate a greater understanding.	
RD0018	A procedure for the joint of handouts must be provided, producing a unique support.	REALIZABLE	LOW	Handouts can be inserted into a single support, to avoid losses.	
RD0019	The duration of the safety class must be at least 8 hours.	REALIZABLE	LOW	It is required a specific training on security which will then be integrated and reviewed during the practical training for the kart construction.	Technology teacher
RD0020	The duration of the class on electrical technology for hybrid and electric technologies must be 20 hours.	REALIZABLE	LOW	Technological training must be able to provide only the basics of hybrid technologies and, at the same time, must have continuity in the implementation phase.	Technology teacher
RD0021	There must be an assessment test regarding	REALIZABLE	LOW	The test at the conclusion of the safety class is necessary to assess	Technology teacher

	the specific information of the safety class.			the achievement of the minimum requirements to operate safely both in the construction phase and in testing on track.	
RD0022	There must be an assessment test to accurately determine the acquisition of the technological skills required.	REALIZABLE	MEDIUM	The test at the end of the electric technology class is necessary to assess the achievement of the minimum requirements to perform the work required in karts.	Technology teacher
RD0023	A series of practical exercises to assess the effective capacity of intervention in hybrid engines must be provided.	REALIZABLE	LOW	Operational capabilities and techniques must be evaluated during the practical workshops to give the students the opportunity to learn by doing and, at the same time, to learn correcting themselves.	Technology teacher

2.2 SECONDARY REQUIREMENTS

CODE	REQUIREMENT	REQUIREMENT EVALUATION	PRIORITY LEVEL	REQUIREMENT DEFINITION AND APPLICATION	REQUIREMENT RESPONSIBILITY
RT0101	The two different models must clearly indicate which of the two systems of hybrid technology are going to apply to be immediately recognizable.	POSSIBLE	HIGH	The models must be immediately recognizable by the colour of the frame and the stickers applied. Material of the same kind of technology will have the same coloration. Graphic details will be decided during processing.	Project manager
RT0102	Models must be provided with plaques bearing the electrical and mechanical characteristics.	POSSIBLE	HIGH	Any electrical and mechanical equipment must be provided with a plaque containing all technical data. Indeed, karts' features must be immediate.	Project manager
RT0103	The two models should be used by students for tests.	POSSIBLE	AVERAGE	The electrical and mechanical features of the karts allow, according to regulations, students to use it on the track. The ability to conduct tests permit students to be more involved in the activities.	Project manager
RD0151	The model must provide connections with other cultural disciplines of the course.	POSSIBLE	AVERAGE	Practice and theory must integrate themselves and make the educational path multidisciplinary and cross. At the beginning the model considers the involvement	Teachers

				<p>of teachers of different subjects: laboratory, technology, science, mathematics and IT (calculation of formulas and realization of tests).</p> <p>Simultaneously the involvement of teachers of cultural subjects (documents in native language) and teachers of foreign languages (brief presentations of the results) is requested too.</p>	
RD0152	<p>During the construction of the model multimedia tools (blog, presentations) are to be used for documentation.</p>	POSSIBLE	AVERAGE	<p>The creation of multimedia products (blogs, video e-books and social forum) allows groups to raise their interest, promotes comparison, autonomy and the narration of what has been achieved, as well as the self-awareness of their own professional path.</p> <p>The multimedia expert promotes the use of these tools in collaboration with students and teachers of the course.</p>	Multimedia expert
RD0153	<p>An e-book must be developed with the description of its main characteristics: how to carry it, how versatile it is and how it could be repeated.</p>	POSSIBLE	HIGH	<p>Need to find a tool to support the project: the e-book was chosen since it allows you to include information about the products and relate external links.</p> <p>The access to lecture notes is</p>	Multimedia expert

				<p>immediate and intuitive. The multimedia expert will involve the students in the creation of the document. If not possible because of lack of technical skills, the choice may fall on other tools.</p>	
RD0154	Multimedia products to be realized by the students.	POSSIBLE	AVERAGE	<p>Supported and tutored by a multimedia expert, the students have to realize multimedia products (blog, social network, e-book...).</p> <p>During the realization, priority has to be given to the direct execution by the students, more than to the contents. Easiest structures are allowed only if totally managed by the students.</p>	Multimedia expert
RD0155	Multimedia products must contain pictures and videos referred to the planning, realization and test of the project.	POSSIBLE	HIGH	<p>Pictures and videos must be attached to the text, lending an immediate and easy comprehension of the project.</p> <p>The video has to be well-structured and the script must include the participation of all stakeholders.</p>	Multimedia expert
RD0156	Connections between other subjects of the course	POSSIBLE	HIGH	<p>Practice and theory must integrate themselves and make the educational path multidisciplinary</p>	Laboratory teacher Technology teacher

				<p>and cross.</p> <p>The constant cooperation between laboratory teachers and technology teachers will involve the common realization of technical handouts and models.</p>	
RD0157	<p>Connections between other technical subject of other electrical sectors (electro technology, CADelet, electrical laboratory).</p>	POSSIBLE	AVERAGE	<p>Practice and theory must integrate themselves and make the educational path multidisciplinary and cross.</p> <p>The collaboration and the link between the subjects must continue during the kart realisation, to make it easier for the users to understand the contents.</p>	<p>Laboratory teacher Technology teacher</p>
RD0158	<p>Models have to be easily reproducible</p>	POSSIBLE	AVERAGE	<p>The aim of the process is to bring the theory about hybrid karts within the reach of all the people with the minimum required competence.</p> <p>The reproduction on different car models has to be easy and intuitive thanks to the choice of materials and the help of multimedia. The process documentation needs to be used also as operational instruction for the realisation by other entities.</p>	<p>Laboratory teacher</p>

RD0159	CO2 emissions must be less than in the original model.	POSSIBLE	HIGH	Hybrid technology provides for the reduction of pollutants by definition. If this condition has not occurred in testing, the used materials and the carried-out processing must be examined. Reducing emissions means also to define a parameter for performance verification.	Laboratory teacher
RD0160	There must be a minimum energy loss.	POSSIBLE	AVERAGE	Hybrid technology must be considered as a tool to save energy, and in this perspective the dispersion control becomes an important requirement. During construction there will be a system for recovering energy to intervene directly in the dispersion.	Laboratory teacher
RD0161	Quality, low cost and durability must be assured.	POSSIBLE	HIGH	Attention and prudence in the choice of materials is required, to let the costs be contained, to have a high-quality product and with the required safety standards. A reference budget for each item will be assigned to the purchasing unit. The order of importance of the parameters will be: price, duration, quality.	Laboratory teacher Project manager
RD0162	The performance should be	POSSIBLE	LOW	To obtain an effective result, it is	Laboratory teacher

	as close as possible to the original model.			<p>necessary that the power of the karts does not undergo noticeable changes.</p> <p>The performance (power, speed, acceleration) must not undergo noticeable changes. In any case, this type of performance is not the main target of the intervention, but it is intended to provide reference parameters on the quality of work.</p> <p>If the final performance differs substantially from the initial one, the laboratory teacher will try to understand together with the students if the causes are due to errors during the processing or to the choice of materials.</p> <p>Also in case of different performance a counselling with the business managers will be requested to check the opportunities for improvement.</p>	
RD0163	The manuals must be clear and intuitive for an easy understanding by the students or for the re-use in other training areas.	POSSIBLE	HIGH	The manuals, generated also with multimedia products (e-book), should be graphically accurate and, at the same time, they should be understandable also for those who have minimum requirements for the construction.	Technology teacher

				The task of the teachers is to create a document that responds directly to requests made by students during the realisation phase, using a simple language.	
RD0164	Multimedia products should facilitate understanding, support the resolution of any problems and improve learning.	POSSIBLE	AVERAGE	<p>Multimedia products (blog, video e-book, social forum) allow free access to groups of interest, comparison, promote independence and the narration of what has been achieved, and so learning and self-awareness of their professional growth.</p> <p>The task of the multimedia expert is to use as many multimedia products as possible, respecting the simplicity of use and the budget constraints. The choice of materials will depend largely on the skills of the users.</p>	Multimedia expert
RD0165	The realization of the model must be led so as to promote the concept of teamwork.	POSSIBLE	HIGH	<p>Working groups must be promoted to increase the comparison-dialogue among equals: the group is a place of learning that promotes autonomy, self-awareness and motivation; the teacher is the mediator.</p> <p>This will avoid traditional classes where the teacher transmits</p>	Laboratory teacher Project manager

				<p>contents, but hardly knowledge.</p> <p>The task of the trainers is to encourage moments of brainstorming and discussion, deepening from time to time themes based on the needs emerged during work and on the requests of the students, following a more active approach.</p>	
RT0166	<p>The testing must be conducted on specific documents to let the users use the correct, effective methodologies and reporting tools.</p>	POSSIBLE	AVERAGE	<p>Tests conducted on the forms are necessary for the ongoing analysis of the parameters of the karts, for adjustments and for the determination of the technical specifications to be included in the licence plate on the chassis and in the relative manuals.</p> <p>The test and its report will be produced using special spreadsheets providing graphic functions and statistics.</p>	<p>Laboratory teacher</p> <p>Project manager</p>
RT0167	<p>A short performance analysis must be produced, comparing the two models before processing the conversion into hybrid.</p>	POSSIBLE	AVERAGE	<p>The comparison between the endothermic karts is necessary to verify the initial situation and to find possible technical differences not detected at the time of purchase.</p> <p>The analysis of the initial</p>	<p>Project manager</p>

				performance will be contained in the final test report.	
RT0168	A brief analysis of each of the two models must be produced comparing the initial performance with the final one, after the conversion into hybrid.	POSSIBLE	AVERAGE	<p>The analysis of the hybrid karts and the subsequent comparison with the originals are needed to study the technical characteristics obtained.</p> <p>If they are faithful to the technological study and if the target of reduction in consumption and pollutants for the same performance have been maintained.</p>	Project manager

2.3 TECHNICAL REQUIREMENTS

REQUIREMENT CODE	STARTING REQUIREMENT	REQUIREMENT EVALUATION	PRIORITY LEVEL	REQUIREMENT INTERPRETATION AND FULFILMENT	REQUIREMENT SUPERVISOR
RF0001	The starter must be electric.	REALIZABLE	AVERAGE	The starter, as the original, must be electrical to make it easy and immediate the kart's use. During realization it will be kept the original starter.	Laboratory teacher
RF0002	Batteries must be lithium-ion.	REALIZABLE	AVERAGE	Lithium-ion batteries have one of the best weight/ power ratio, no memory effect and a slow loss of charge when not in use; they can be made in a wide range of shapes and sizes, in order to efficiently fill the available space in the kart. These batteries are lighter and have a very high charge density. They also have a low self-discharge rate of approximately 5% per month. The person in charge to purchase will verify that condition during the choice of materials. Advice from the companies involved in the project are expected to define purchases, in order to better select the suitable	Laboratory teacher

				materials. The basic principle followed is that of cost-benefit.	
RF0003	The use of induction electric engines for the traction is planned because of low costs, reliability and high yield.	REALIZABLE	HIGH	An asynchronous engine is used for the advantages of lower maintenance, good starting torque and higher yield. The person in charge to purchase will verify that condition during the choice of materials. Advice from the companies involved in the project are expected to define purchases, in order to better select the suitable materials. The basic principle followed is that of cost-benefit.	Laboratory teacher
RF0004	The "first engine" has to be endothermic.	REALIZABLE	HIGH	The karts are designed in a "hybrid" technology so the endothermic engine must be the "first engine". This basics must be followed by the laboratory teacher and explained to the students in charge of the realization.	Laboratory teacher
RF0005	A storage system is provided.	REALIZABLE	HIGH	Batteries must be used because they have an energy density lower than that of the fuel, they can be regulated to accumulate the maximum energy, to exchange the maximum power.	Laboratory teacher

RF0006	There shall be a minimum autonomy for the pure electric mode.	REALIZABLE	LOW	The pure electric mode is an additional element of the didactic model, that's why the priority given is low. However, the person in charge to purchase will choose the electric engine to be used even in this case, always within the budget constraints.	Laboratory teacher
RF0007	There shall be a minimum operating power in "pure electric".	REALIZABLE	LOW	The pure electric mode is an additional element of the didactic model, that's why the priority given is low. However, the person in charge to purchase will choose the electric engine to be used even in this case, always within the budget constraints.	Laboratory teacher
RF0008	There shall be a minimum operating power in hybrid.	REALIZABLE	AVERAGE	The person in charge to purchase will verify the engine's power while buying it. At this stage the collaboration of the companies representatives is expected, in order to better select the suitable materials. The basic principle followed is that of cost-benefit.	Laboratory teacher

3. REQUIREMENTS APPLICATION: PERFORMANCE REQUIREMENTS

The tests for the evaluation and the comparison of the performances between the two models have as main requirement the simplicity of realization and of the data interpretation. The possibility for users themselves to carry out autonomously the test activity is an essential requirement, because it allows to acquire solving and reporting skills.

The testing process must include:

- the use of several repetitions for each parameter analysed, in order to obtain more relevant data
- a comparison between the performances of the model before processing and the two hybrids realized, with values indicated as a percentage.

In general no goals are set on the performances and the comparisons made, because the didactic process is aimed at the acquisition of a methodology and not at the evaluation of a final product.

TARGET SKILLS	<ul style="list-style-type: none"> - Analytic skills: student have to apply different techniques to analyse performances and understand the meaning of indicators - Communicative skills: students have to make a report clear, simple to read and complete.
ACCOUNTABLE	Laboratory trainer/teacher
DEVELOPERS	Students
TIME NEEDED	1 to 3 days
ADDITIONAL SUBJECT INVOLVED	Maths/scientific subject or IT teacher
FINAL OUTPUT	Testing report

CODICE REQUISITO	REQUISITO INIZIALE	VALUTAZIONE REQUISITO	PRIORITA'	INTERPRETAZIONE DEL REQUISITO E REALIZZAZIONE	RESPONSABILE REQUISITO
RP0001	Deve essere definito un test di velocità di confronto tra il modello iniziale e ciascuno dei due modelli trasformati. I test devono essere facilmente realizzabili.	REALIZZABILE	BASSA	<p>1) Il test di velocità dovrà essere realizzato su un circuito comprendente rettilinei e curve, con guida regolare e sicura (non sportiva).</p> <p>2) Le prove di velocità dovranno essere condotte dallo stesso allievo su ogni modello.</p> <p>3) Si prevedono almeno 5 prove per modello.</p> <p>4) I dati utilizzati saranno media e varianza.</p> <p>5) I dati dovranno essere riportati su foglio elettronico e dovranno essere corredati da grafici.</p> <p>La priorità attribuita è bassa in quanto il confronto sulla velocità non rappresenta uno degli elementi cruciali per la valutazione della tecnologia elettrica.</p>	Formatore-docente materie scientifico-matematiche o informatiche Formatore di laboratorio
RP0002	Deve essere definito un test sui consumi di confronto tra il modello iniziale e ciascuno dei due modelli trasformati. I test devono essere facilmente realizzabili.	REALIZZABILE	MEDIA	<p>1) Il test sui consumi dovrà essere realizzato su un circuito comprendente rettilinei e curve, con guida regolare e sicura (non sportiva), utilizzando 0,5 litri di carburante e valutando la distanza</p>	Formatore-docente materie scientifico-matematiche o informatiche Formatore di

				<p>percorsa in giri e frazioni di giro.</p> <p>2) Le prove di consumo dovranno essere condotte dallo stesso allievo su ogni modello.</p> <p>3) Si prevedono almeno 3 prove per modello</p> <p>4) Il dato utilizzato sarà la media.</p> <p>5) I dati dovranno essere riportati su foglio elettronico e dovranno essere corredati da grafici</p>	laboratorio
RP0003	<p>Deve essere definito un test su ripresa/accelerazione di confronto tra il modello iniziale e ciascuno dei due modelli trasformati. I test devono essere facilmente realizzabili.</p>	REALIZZABILE	BASSA	<p>1) Il test sull'accelerazione sarà realizzato su un rettilineo di almeno 100 m., e sarà misurato quanto tempo necessario a raggiungere un determinato punto di controllo partendo da fermo.</p> <p>2) Le prove di accelerazione dovranno essere condotte dallo stesso allievo su ogni modello.</p> <p>3) Si prevedono almeno cinque prove su ogni modello</p> <p>4) I dati utilizzati saranno media e varianza.</p> <p>5) I dati dovranno essere riportati su foglio elettronico e dovranno essere corredati da grafici</p> <p>La priorità attribuita è bassa in quanto l'analisi dell'accelerazione</p>	<p>Formatore-docente materie scientifico-matematiche o informatiche</p> <p>Formatore di laboratorio</p>

				non rappresenta uno degli elementi cruciali per la valutazione della tecnologia elettrica.	
RP0004	Deve essere definito un test sulle emissioni di confronto tra il modello iniziale e ciascuno dei due modelli trasformati. I test devono essere facilmente realizzabili.	REALIZZABILE	MEDIA	<p>1) Per la realizzazione del test deve essere utilizzato apposito strumento diagnostico</p> <p>2) Le prove vanno eseguite con motore a caldo, dopo aver eseguito almeno uno dei test precedenti.</p> <p>3) Devono essere previste almeno tre prove di verifica,</p> <p>4) Il valore considerato sarà la media dei tre valori, e sarà considerato valido solo se le tre misurazioni rientreranno in un campo di variabilità inferiore al 5%.</p> <p>5) I dati dovranno essere riportati su foglio elettronico e dovranno essere corredati da grafici</p>	<p>Formatore-docente materie scientifico-matematiche</p> <p>Formatore di laboratorio</p>
RP0005	Deve essere definito un test sull'assorbimento di corrente per valutare la diversa efficienza tra i due modelli creati.	REALIZZABILE	MEDIA	Mediante l'utilizzo del tester (multimetro) è possibile misurare l'assorbimento di corrente dei due veicoli. I dati verranno inseriti in tabelle esemplificative per confrontare l'efficienza dei due collegamenti.	<p>Formatore-docente materie scientifico-matematiche</p> <p>Formatore di laboratorio</p>
RP0006	Deve essere definito un test per valutare i Cavalli	REALIZZABILE	MEDIA	Dalle tabelle, debitamente compilate, è possibile calcolare la	Formatore-docente materie

	effettivamente sviluppati per valutare le differenze di potenza tra i due modelli e con il modello iniziale.			potenza e i cavalli sviluppati per valutare la differenza di potenza dei due modelli.	scientifico- matematiche Formatore di laboratorio
RP0007	Il design dovrà essere progettato per soddisfare i requisiti minimi di stabilità e aerodinamicità, non prestazionali ma per la sicurezza dell'utente.	REALIZZABILE	MEDIA	Deve essere mantenuto il design dei mezzi originali per garantire una sicurezza aereodinamica adeguata e certificata dalla casa costruttrice. Ove ci siano cambiamenti prettamente necessari, per l'inserimento del gruppo batterie e dell'apparato elettrico, saranno progettate alcune modifiche nella carena per garantire stabilità e maneggevolezza.	Formatore di laboratorio

4. REQUISITI DI QUALITÀ

CODICE REQUISITO	REQUISITO INIZIALE	VALUTAZIONE REQUISITO	PRIORITA'	INTERPRETAZIONE DEL REQUISITO E REALIZZAZIONE	RESPONSABILE REQUISITO
RQ0001	La durata del “pacco batterie” deve coprire almeno un anno formativo.	REALIZZABILE	BASSA	<p>Per la scelta delle batterie da utilizzare devono essere coinvolte le aziende che operano nel campo della mobilità elettrica, che indirizzeranno e consiglieranno l’acquisto dei materiali. La definizione della durata è stata decisa in modo che l’esaurimento delle batterie non diventi una variabile in grado di condizionare le prestazioni ottenute e l’attività di realizzazione.</p> <p>Se il costo è eccessivo è comunque possibile orientare la scelta su materiali che garantiscono una durata minore.</p>	Formatore di laboratorio
RQ0002	L’attività realizzativa deve prevedere il coinvolgimento di almeno 15 allievi.	REALIZZABILE	BASSA	<p>Il numero di 15 allievi è definito come ottimale perché tutti possano essere coinvolti nella fase di realizzazione ed il gruppo non sia eccessivamente ristretto. La priorità è ritenuta bassa perché un numero ridotto di utenti (fino ad 8) consente comunque di realizzare</p>	Responsabile del progetto

				pienamente l'attività prevista. Da valutare invece l'opportunità e la qualità dell'intervento complessivo per un numero di destinatari più alto.	
RQ0003	L'attività di test e di verifica deve prevedere ripetizioni di più prove considerando media e variabilità dei risultati.	REALIZZABILE	MEDIA	L'attività di test prevede la ripetizione di più prove, soprattutto dove gli indicatori sono maggiormente rilevanti per un confronto di prestazioni e la valutazione delle caratteristiche e dell'impatto della tecnologia elettrica sugli autoveicoli. L'attività di testing sarà condotta in collaborazione con un docente di discipline matematiche per quanto riguarda gli aspetti statistici delle prove o da un docente di materie informatiche per quanto riguarda l'utilizzo dei fogli di lavoro e le funzioni statistiche collegate.	Formatore di laboratorio Formatore di materie matematico-informatiche
RQ0004	L'attività deve prevedere la stesura di documenti, relativi alle varie fasi, pubblicati nei prodotti multimediali.	REALIZZABILE	MEDIA	La realizzazione di prodotti multimediali (quali blog, video e-book e social forum) permette il libero accesso di gruppi di interesse, confronto, promuove l'autonomia e la narrazione di quanto realizzato, quindi, l'apprendimento e l'autoconsapevolezza del proprio	Reponsabile del corso/Esperto prodotti multimediali

				percorso professionale.	
RQ0005	Deve essere prevista una autonomia minima in “puro elettrico”.	REALIZZABILE	BASSA	<p>L'autonomia prevista nel funzionamento in “puro elettrico” deve essere di almeno 30'. A questo aspetto è comunque attribuita una priorità ridotta in quanto il nucleo del progetto è la realizzazione di veicoli ibridi.</p> <p>In fase di realizzazione possono essere apportati cambiamenti all'autonomia minima in puro elettrico sulla base delle caratteristiche tecniche dei materiali utilizzati. Eventuali modifiche saranno apportate su questo documento.</p>	Formatore di laboratorio
RQ0006	Deve essere prevista una potenza minima in “puro elettrico”.	REALIZZABILE	BASSA	<p>La potenza prevista nel funzionamento in “puro elettrico” deve essere di almeno 4 Kw. Anche in questo caso la priorità è bassa perché il progetto verte su due veicoli ibridi.</p> <p>In fase di realizzazione possono essere apportati cambiamenti alla potenza minima in puro elettrico sulla base delle caratteristiche tecniche dei materiali utilizzati. Eventuali modifiche saranno apportate su questo documento.</p>	Formatore di laboratorio

RQ0007	Deve essere prevista una potenza minima di funzionamento ibrido.	REALIZZABILE	MEDIA	<p>La potenza prevista nel funzionamento ibrido deve essere di almeno 9 Kw.</p> <p>In fase di realizzazione possono essere apportati cambiamenti alla potenza minima in puro elettrico sulla base delle caratteristiche tecniche dei materiali utilizzati. Eventuali modifiche saranno apportate su questo documento.</p>	Formatore di laboratorio
RQ0008	Durante la fase di collaudo, deve essere previsto il controllo delle emissioni di CO ₂ .	REALIZZABILE	MEDIA	L'analisi dei Gas di scarico e delle emissioni è prevista in fase di valutazione delle prestazioni, dove sono indicate anche le modalità di conduzione dei test	Formatore-docente materie scientifico-matematiche
RQ0009	Durante la fase di collaudo, deve essere previsto il controllo della dissipazione di energia.	REALIZZABILE	MEDIA	<p>Attraverso i test "al banco" di collaudo è possibile il controllo della dissipazione di energia.</p> <p>Si useranno tabelle esemplificative per inserire i dati e il calcolo delle incognite.</p>	Formatore di laboratorio

5. ALTRI REQUISITI

CODICE REQUISITO	REQUISITO INIZIALE	VALUTAZIONE REQUISITO	PRIORITA'	INTERPRETAZIONE DEL REQUISITO E REALIZZAZIONE	RESPONSABILE REQUISITO
RA0001	I due modelli devono riportare il logo del progetto sulla carrozzeria.	REALIZZABILE	MEDIA	<p>Per promuovere il percorso, darne visibilità e una identità chiara ma anche per facilitare l'accesso al percorso multimediale ed esplicativo delle fasi del processo formativo, è necessario rendere visibile il logo del progetto nella carrozzeria.</p> <p>Per la realizzazione verrà inizialmente richiesto uno studio di fattibilità al settore grafico e ai partner aziendali. La scelta della modalità da seguire risponderà, ai seguenti criteri indicati in ordine di importanza: economicità, praticità, durata, tempi di realizzazione, qualità.</p>	Formatore di laboratorio Responsabile del progetto
RA0002	I due modelli devono riportare il logo dell'Ente di formazione professionale sulla carrozzeria.	REALIZZABILE	BASSA	Al secondo posto in ordine di importanza si colloca la promozione dell'Ente formativo che ha realizzato il prodotto e che lo esporrà anche al termine del	Formatore di laboratorio Responsabile del progetto

				<p>progetto all'interno dei propri laboratori.</p> <p>Le modalità di realizzazione del logo seguiranno gli stessi principi indicati per il logo del progetto. In caso di scarsità di risorse verrà realizzato solo il logo generale del progetto.</p>	
RA0003	I due modelli devono riportare il logo dei partner sulla carrozzeria.	REALIZZABILE	BASSA	<p>A parità di importanza si ritiene dare visibilità ai partner che hanno collaborato alla realizzazione, secondo gli stessi principi e modalità già espressi in precedenza.</p> <p>Qualora non sia possibile inserire il dei partner sulla carrozzeria si ritiene di non inserire neppure quello dell'Ente di formazione ma soltanto quello del progetto.</p>	Formatore di laboratorio Responsabile del progetto
RA0004	Il painting e gli stickers dei modelli dovranno essere coerenti e di appeal e verranno progettati dagli allievi.	REALIZZABILE	MEDIA	<p>Il painting e gli stickers devono essere progettati dagli allievi perché sia un progetto che appartiene a loro dalle fasi realizzative e di controllo fino alla realizzazione della carena: tali azioni devono essere guidate da un tecnico di laboratorio grafico oppure da un rappresentante aziendale, sempre appartenente al</p>	Formatore di laboratorio Responsabile del progetto

				settore grafico.	
RA0005	I prodotti multimediali devono essere presentati con particolare attenzione alla cura grafica.	REALIZZABILE	MEDIA	<p>Ogni prodotto multimediale deve essere progettato accuratamente per facilitare un accesso intuitivo e semplice ma, nello stesso tempo, di appeal. Si ritiene che la capacità di coinvolgimento del progetto dipenda in maniera significativa dall'attrattività degli strumenti utilizzati.</p> <p>Tali prodotti, non devono avere contenuti prolissi o con un linguaggio strettamente tecnico perché possono distrarre l'attenzione e limitare l'apprendimento. In fase di realizzazione gli allievi devono essere coinvolti nella realizzazione del materiale stimolando domande e richieste a cui il materiale prodotto dovrà dare risposta.</p>	Esperto prodotti multimediali
RA0006	I manuali devono essere impaginati in modo oculato.	REALIZZABILE	MEDIA	<p>E' necessaria una accurata impaginazione dei manuali per consentire un facile e intuitivo accesso al percorso formativo e alla produzioni di motori "ibridi elettrici" anche a persone con requisiti minimi di base. I manuali devono avere l'obbiettivo di avvicinare alla tecnologia in esame</p>	Esperto prodotti multimediali

				<p>e non di appesantire lo studio e l'acquisizione dei concetti. Il coinvolgimento diretto degli allievi che andranno ad identificare durante il lavoro quali competenze tecnologiche sono necessarie per la realizzazione è una delle modalità attraverso cui si intende produrre materiale più coinvolgente. Si prevede inoltre la collaborazione con docenti esperti di materiale multimediale e consulenti operanti nel settore grafico.</p>	
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6. POSSIBILI SVILUPPI FUTURI

Questa attività deve essere vista come primo modulo introduttivo alla mobilità elettrica da sviluppare in un Ente di Formazione Professionale. Ovviamente il contesto di riferimento è essenziale per tarare l'attività svolta alle reali esigenze del territorio. Per evitare che l'attività sviluppata resti isolata dal sistema didattico-formativo dell'Ente, si ritiene utile ipotizzare interventi ed azioni future ad integrazione e sviluppo dell'iniziativa, ovviamente nel rispetto dei vincoli di budget e di tempo imposti dalla necessità di svolgere comunque o contenuti obbligatori previsti nei percorsi.

Come possibili sviluppi si prevede:

- 1) Adattare l'intervento svolto sui kart ad un'automobile: tale azione può essere realizzata seguendo lo stesso schema adottato in questo manuale: In alternativa, nel caso esistano effettivamente troppi vincoli per condurre l'attività concretamente, potrà essere realizzato uno studio teorico sulle diverse caratteristiche dei materiali richiesti per convertire un autoveicolo.
- 2) Acquisire un veicolo ibrido ed un veicolo elettrico su cui condurre prove ed esercitazioni guidate sulla diagnostica e risoluzioni di guasti simulati. Questo rappresenta uno dei punti di arrivo per poter rendere inserire in maniera sistematica e strutturata la mobilità elettrica all'interno del percorso formativo.

Ulteriori opportunità di sviluppo possono essere definite in itinere.

7. ELEMENTI DI VERIFICA E CONTROLLO

Al termine delle attività realizzate, per valutare l'efficacia del modello formativo sarà completata la seguente tabella per una prima valutazione dei risultati. In particolare saranno valutati:

- Quanti requisiti sono stati rispettati
- Quanti momenti di collaborazione sono stati realizzati nell'attività
- Eventuali problematiche specifiche

TIPO DI REQUISITO	REQUISITI INIZIALI	REQUISITI RISPETTATI	NUMERO MOMENTI DI COLLABORAZIONE-CONSULENZA SCUOLA/AZIENDE	PRINCIPALI PROBLEMI RISCONTRATI
REQUISITI TECNICI GENERALI	18			
REQUISITI TECNICI KART 1 – MODELLO IN SERIE	5			
REQUISITI TECNICI KART 2 – MODELLO IN PARALLELO	5			

REQUISITI DIDATTICI (DISPENSE)	21			
REQUISITI DESIDERATI (TECNICI E DIDATTICI)	21			
REQUISITI DI FUNZIONAMENTO	8			
REQUISITI PRESTAZIONALI	7			
REQUISITI QUALITATIVI	9			
ALTRI REQUISITI	6			
TOTALE	100			

Ovviamente la qualità del lavoro svolto non sarà misurata soltanto da questi elementi, ma anche dalla profondità delle attività di disseminazione e diffusione realizzate e dagli indicatori specifici di progetto. La seguente tabella si intende utilizzabile dall'Ente di formazione per un'analisi interna della conformità del seguente documento ed una prima valutazione del lavoro svolto. Sulla base dei risultati che possono emergere è possibile definire revisioni del manuale od interventi migliorativi dell'azione.