Riferimento a linee guida	FORM N.: 3 PROGRAM EVALUATION FORM
3	Nome programma:
	Electric Power Systems
3	Responsabile programma
	Roberto Caldon
3	Obiettivi specifici del programma
	The research activities carried out in the years 2001-2005 have been in the fields of generation, transmission and distribution of electric power, with particular emphasis on innovative technologies and means to improve system performances accounting for technical, economical and environmental constrains in a liberalized electricity market. The main research topics are 1) Impact of Dispersed generation on the electric system 2) Distribution line carrier 3) Innovative technologies for power electric transmission 4) Multiconductor analysis of electric lines 5) Analysis and mitigation of environmental magnetic fields 6) Energy economics
3	Progetti in corso
	Project 1: Impact of Dispersed Generation on the electric system The advent of new technologies, different environmental policies, deregulation of power generation and distribution, have led to a growing interest in distributed resources (generation and storage units within the range of a few kW to some MW), usually connected to the low voltage or medium voltage grids. These units have a variety of physical characteristics and produce power from either fully renewable primary energy sources or semi-renewable sources (such as combined heat and power plants). It is foreseen that in the growth of electric power systems large production stations will progressively be paralleled by the so called "distributed generation", which is intended as a not centrally planned small generation whose growth is bound to affect the power system. The electric distribution network may play a new role as a link between users (which are in the meantime consumer and producer) rather than a mere power conduit for the loads. As a consequence it is strategic to re-considered the entire distribution system, as regards its nature, management and configuration. The research work carried out by the Power Systems Group have faced different aspects concerning mutual influence between dispersed generators and network and possible actions to allow their integration. In particular: - protection against islanding (the most challenging aspect to be ensured in order to allow DG a large diffusion) have been studied. The operating conditions which may lead these protections failing to detect the isolation of generator site from utility supply (non-detecting zone) have been identified; methods for improving reliability have been

proposed.
- the impact of dispersed generators electro-mechanical transients on distribution system operation has been studied. Particular emphasis has been given, by means of laboratory tests and systematic simulation of the various types of generating plants, to the possible disturbance injected into the network (overvoltages, harmonics, voltage sags and fluctuations, etc…).
The research is also addressed towards novel methods and strategies for voltage regulation of distribution networks with substantial dispersed generators. The aim is to develop automatic control systems, even based on AI, for controlling the reactive production of each independent generation.
To this aim a co-ordinated voltage/reactive power control scheme has been proposed, it enables the dispersed generators to participate, together with the HV/MV substation OLTC transformer, to the node voltage regulation of the feeder they are connected to, thus ensuring a better voltage profile along the distribution feeders.
This project has been developed in collaboration with CESI SpA, within the "Ricerca di Sistema" national grant .
Of considerable interest is the idea of aggregating a number of small and medium size generators, of different type and location, capable of generating both electric and thermal power, into a single Virtual Power Plant (VPP). By interconnecting different DGs, through a suitable communication protocol, a number of advantages can be gained for both utility and private producers.
A better way to realize the emerging potential of distributed generation is to take a system approach which views generation and associated loads as a subsystem or a "microgrid". In order to apply this concept, a number of problems must be solved. First of all the protection system must provide protective devices capable to work correctly both in the grid connected mode and in islanded mode. To this aim has been investigate the possibility of applying new protection schemes by pointing out traditional and innovative techniques for maintaining coordination and by developing methods to assure protection for an islanded portion of the system supplied by DGs.

Project 2: Distribution Line Carrier
Distribution Line Carrier communication is not at all a new concept for utilities, however potential exists for electricity distribution companies to leverage the value represented by advanced data communications for instance in managing a large penetration of dispersed generations. As well known, the usefulness of signal level is strictly linked to the attenuations of the media.
The distribution network is a rather complex structure, formed by many components having different electric characteristics (e.g. overhead lines and cable lines), therefore it is not simple to know in advance the propagation behaviour of a signal along the network because of the proper circuit attenuations, the mismatching and standing wave patterns, the effects of capacitor banks, the branching (forked line) and the splice of different line segments. To this aim a procedure that allows determining, for a signal injected in a given network, the strength of signal level at each node has been developed.
The feasibility of a relay protection based on DLC signal is investigated for MV distribution systems. The original idea at the basis of the proposed protection technique is to use MV lines as the support to transmit a high frequency signal from the primary substation up to the DG. Any tripping on the MV line (for example, to clear a fault) determines the lack of this signal and this will force the generator to be disconnected from the grid.
It is planned to develop, with the collaboration of SELTA SpA, a prototype of carrier

signals (CS) based protection device, whose performance under different operating conditions will be tested on a real 20 kV network in collaboration with ENEL Distribuzione S.p.A. .

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Project 3: Innovative technologies for power electric transmission

This field of research has been extensively investigated since many years in the Power System Research Group and is framed, more generally speaking, into the well-established tradition of the Group on electrical transmission. In particular the new power transmission technologies of Gas Insulated Lines - GIL and XLPE underground cables (UGC) have been deeply analysed and studied. A meaningful example of integration of railway transport and electric transmission can be realized with the installation of a GIL system in the pilot tunnel of future high-speed railway galleries foreseen under the Brenner Pass from Fortezza to Innsbruck. An upgrading and requalification of both railway traffic and energy exchange of transnational grids can be achieved in a very important and central European area. The electric system (GIL double-circuit) offers a high power performance and most of all guarantees both safety for personnel and continuity of operation by means of re-closure cycles, determinative factors in the comparison with other traditional transmission technologies. The importance of this idea is confirmed by the support given by European Community to the feasibility study of 380 kV reinforcement of Italy-Austria interconnection for the development of European Energy Market. Subsequently, this research has been supported by European Community in the framework of TEN-ENERGY programme for analysing both, technical and environmental issues of integrating 380 kV Gas Insulated transmission Line and Rail Transport in tunnel between Italy and Austria entitled "Studies for a new 380 kV transmission line between Italy and Austria through the Brenner pass: Integration of Electricity and Rail Transport in Tunnel". The project leader has been TERNA (Italian TSO) whereas the associated beneficiaries have been the University of Padova and TIWAG-Netz AG (Tyrol TSO) with support of Graz University of Technology. The high GIL power ratings with very low power losses would allow a strong and highly efficient energy exchange particularly useful for the future European Market and could represent a new fundamental step in reconstructing the European interconnection network. Two separate railway tunnels will run under the Brenner Pass from Fortezza (Italy) to Innsbruck (Austria) but will be preceded by the construction of a continuous pilot tunnel useful for work logistics and chiefly for detection of the rock stratigraphy. Once the whole work will be over, the pilot tunnel will be used as a service gallery (drainage of water) where a double-circuit GIL can be efficiently installed.

The research has been focused on the main characteristics of planned galleries, the transmission line and its performance, the electro-magnetic field impact considering the proximity effects and the earthing arrangement in order to zero the touch-voltages in case of phase-to-enclosure short-circuit. The chief features of GIL solution are the lowest transmission power losses and the absence of shunt reactive compensation for this line length (appr. 65 km) but mostly the safety of personnel in case of short-circuit and the possibility of usual re-closure cycles for operation continuity. The feasibility study has also analysed: GIL no-load regime, electromagnetic interferences between railway and GIL system, pilot tunnel ventilation and GIL thermal regime. In order to achieve satisfying power flows, the new link requires both Italian/Austrian regional grids (380 kV÷110 kV) to be restructured and rationalised.

With regard to XLPE cables, the enforcing and widening of transmission grid, which is nowadays considered necessary by all parties, are experienced strong difficulties in erecting new overhead lines. This has brought to attention the use of underground

transmission technologies: in primis the cable lines (UGC). In order to erect a new long link, it could be necessary to have a mix of transmission technologies such as a cascade connection of overhead –cable-overhead lines. In fact, UGCs result more suitable to land constraints and can overcome orographical hindrances. For example, an UGC section allows a HV/EHV link to pass through areas too wide for OHL span such as large rivers or lakes. Very often, the substitution of some OHL spans with UGC is named as "siphon". This configuration may also solve some critical cases due to strongest local oppositions since it drastically reduces the environmental and magnetic impacts and hence it permits the transmission line to pass through or near a protected site (sensible places such as kindergarten) or an urbanised area. It is worth remembering that some important installations of mixed OHL-UGC link have been realised since several years to allow great power flows in great town centres. For all the aforementioned reasons, the transmission system operators will have to face more and more the analysis of mixed lines. The power system group has developed the transmission performances of the mixed link by means of capability charts already conceived for cable lines by the authors. These new capability charts are enhanced with informative parameters, which allows having a comprehensive knowledge of the steady-state regimes of a given mixed line. The necessity of limiting the overvoltages during mixed line energization by means of shunt reactive compensation has been investigated and criteria for choosing the compensation degree have also been presented.
A further research activity carried out in this period has focused on the evaluation of the technical and economical performances of the existing different power transmission technologies which may be for interconnecting the Italian grid with neighbouring systems, research conducted within the framework of “Ricerca di Sistema” national grant in collaboration with CESI

Project 4: Multiconductor analysis of electric lines
In this context, the Power System Group of the Department of Electrical Engineering of the University of Padova has developed an automatic algorithm (based upon the matrix analysis of multiconductor systems), which takes into account the inductive and capacitive coupling with earth wires and other three-phase lines as well.
This matrix multiconductor algorithms have been successfully applied to:
- analysis of the supply of warning discharge lamps installed atop towers by means of the insulation of ground wires in HV and EHV. To this issue, a simplified yet efficient matrix procedure which allows both to compute the capacitive induced voltages and to determine the equivalent circuit supplying such non-linear loads. In addition, the waveform of the conduction currents and voltages and the average power on the lamps are determined by a fast analytical procedure. The analytical results have been compared with laboratory experimental results giving a really good agreement.
- throughout study of overpassings between overhead lines and ropeways. There are many places, in Italy and in Europe, where electric overhead lines, with different voltages, overpass ropeways. The accidental fall of high and extra high voltage electric conductor onto the wire rope would represent a traumatic occurrence beyond to the persons also to the ropeway installations for both the mechanical actions and the electric arc effect, which can damage the wire rope with strong current. The present study has been focused upon the evaluation of the damage of wire rope due to overheating caused by short circuit current, as technical literature on it appears to be missing. In particular answers to the risk of ropeway downfall (with catastrophic consequences) were expected from the electrical experimentation. The results show that the electrical tests always give very heavy damages on rope, which need to be replaced,

but exclude the ropeway downfall (catastrophic effect) because the remaining safety degrees still guarantee the ropeway stability. Due to the lack of previous technical literature on this topic, it is hoped that this study may have contributed to a better understanding of electro-thermal and metallurgic phenomena that arise during short circuits between an overpassing electric line and a wire rope.

Project 5: Analysis and mitigation of environmental magnetic fields

The growing public concern of possible harmful effects caused by human exposure to electromagnetic fields in the 50-60 Hz (extremely low frequency fields) and the difficulties in assessing, or excluding, the risk associated with long term low levels magnetic field exposures, has led several national, and in Italy even regional, bodies to set on prudentially restrictive limitations on the permitted exposure levels, with particular emphasis on the magnetic field component. Because of these limitations, it is necessary to quantify realistically the magnetic field environment associated with electric systems, in particular electric power lines that have the widest impact on the territory.

Combining the expertise in field computation and power systems, the research group has extensively investigated the problem of assessing and mitigating the low frequency environmental magnetic field generated by power lines and installations.

As a result, a comprehensive software package for the computation of the magnetic field generated by O/H power lines under real operating conditions has been developed. The program is based on a detailed modelling of the conductor geometry, and a fast two-dimensional approach is used for the analysis of single lines (whether single or multiple circuits) whereas a three dimensional approach has been implemented which allows the analysis of complex geometries such as intersection of different lines and/or not aligned spans.

For environmental impact analysis, it is important to account for the probabilistic nature of power frequency magnetic field, chiefly due to the continuous variation of the line loading. A Monte Carlo based statistical section of the program allows to investigate the role played by the variation of each of the influencing factors (such as short and long term current fluctuations and variation of ambient parameters) on the resulting environmental fields.

An original procedure has been developed, which combines computer modelling, analysis of historical line current data and magnetic field measurement on selected sites, capable of providing reliable estimates of the magnetic field exposure levels generated by multiple-corridor power line configurations, showing that it is possible to assess the environmental fields generated by complex conductor configurations at any arbitrary location with no need to carry out expensive and time consuming measurement campaigns (measurements can be restricted to selected areas for validation purposes).

At present a research project is being carried out with CESI aimed at developing suitable analytical formulations for easily determining power line right-of-ways of the most commonly used tower configurations of single and double circuits lines. This work will provide the theoretical background for a new Italian standards on this matter.

Power frequency magnetic fields are difficult and expensive to mitigate, particularly when the fields originate from sources with complex patterns, such as MV/LV substations, which represent a typical source of ELF magnetic fields in residential areas, since they are often located inside the buildings. In order to evaluate the emission level or to design a suitable shielding scheme for a substation it is necessary to identify and characterise the different field sources (namely cables, bus bars, transformers and panels). This is not at all a trivial task and can hardly be done solely by measurements,

given the highly irregular spatial distribution of the field and temporal variation of the currents (i.e. field sources) flowing through the different substation components. In order to overcome the above problems, a hybrid procedure has been applied for substation model identification, where the 3D paths of the linear current sources (cables and bus bars) are modelled in detail whereas the other complex sources (transformers and panels) are represented by simple equivalent sources, namely dipoles whose current intensity and orientation are determined on the basis of field measurement under controlled supply conditions.

A novel approach has been proposed for analyzing conducting shields of ELF magnetic fields in linear media. It consists of an integral formulation based on the Cell Method, expressed in terms of network-like loop currents and magnetic vector potential line integrals in the conducting region. This formulation leads to a considerable reduction of field problem variables, thus limiting the amount of allocated memory, and speeding-up the numerical procedure compared to other differential and integral techniques. A detailed comparison between this method and a 3D FEM code demonstrates the accuracy of the results and the advantages of the method.

An other interesting work has been an industrial related project aimed at defining a suitable criterion for the shape design optimization of HV shielding electrodes for reducing the radio interference. The experimental part of the investigation consisted in standard Radio Interference Voltage (RIV) measurements on test geometries with different sized toroidal and spherical electrodes. A detailed 3D modelling of the test geometries has been carried out using a BEM based commercial code, in order to precisely compute the electric field distribution near the electrode surfaces. It has been observed that, despite the different geometries and applied voltages, a unique electric field value is attained in all configurations in correspondence to the RIV threshold voltage. Therefore, this value could be used as a design parameter for CAE tools once the field distribution near the HV device is computed. The proposed approach may greatly improve the efficiency of HV shield design, which nowadays is normally based on empirical considerations.

Besides scientific papers, an important output of the project is an extensive activity of dissemination (lectures and seminars) and technical support to private companies and public administrations. The group actively participate to the CEI (Italian Electro-technical Committee) WG 106A “Human exposure to low frequency electromagnetic fields”.

Project 6: Energy Economics

The scientific activity related to the economics of energy and of the electric power system in particular has been carried out with the support of the Centro “Levi Cases”(*) which operates at DIE . The activity has been focused on the organisation and the regulation of the electricity industry, with close collaborations both with companies and the recently born (1997) regulatory authority. The fast growth of market forces in the electricity sector has posed severe challenges to the operators and the research group has worked for the definition of new rules coherent with the introduction of competition, the security of the power system and the sustainability of investments.

A further area of work is related to the development of renewable energy sources. The contribution of the research group has been aimed at understanding the economic feasibility of investments and identifying the best support policies in terms of efficiency and effectiveness.

The main research projects participated by the personnel of DIE in the frame of Energy Economics are the following:

- Feasibility study for the creation of a Energy Service Company (ESCO) in the

	building sector on behalf of the national association of construction companies (ANCE) (2005 -06, with IEFE). - Incentives to the investments in transmission capacity: goals, policies and instruments, research project sponsored by TERNA and other private companies and conducted jointly by IEFE, ref. and Politecnico of Milan (2005 -06, with IEFE). - FavoRES, Favouring the Convergence of the Renewable Energy Support after the Directive 01/77/EC, EU contract ALTENER 4.1030/C/02-004/2002 financed by DG Tren (2003 – 2005, A. Lorenzoni project coordinator, with IEFE). - The cost of electricity from renewable energy sources, research sponsored by an Italian private company (2005, with IEFE). - Promoting renewables for electricity generation and the connection to the distribution grid, PRIN 2004 at DIE (2005). - Incentives to investments in power generation in the liberalised market, with ref, sponsored by private companies (2004 – 2005, with IEFE). - REDS, Research & Development Spending: a survey of R&D spending for renewable energies sources in EU countries, EU contract NNE5-2002-00092 (November 2002 – October 2003), Accompanying Measures of V FP of the European Commission (A. Lorenzoni Project Coordinator, with IEFE). - Wind power perspective at 2010 in Italy, research aimed at evaluating the prospects of wind power in Italy for a private investor (2003, with IEFE). - Analysis of potential and costs of renewables and cogeneration in Italy, contribution to the Italian Third National Communication under the UN Framework Convention on Climate Change for the Italian Ministry of Environment (January 2003). - Study on the Italian supply of technologies for renewable energy deployment, for the Ministry of the Environment in 2001 (with IEFE and Kyoto Club). (*) The interdepartmental research center called "Centro Studi di Economia e Tecnica dell'Energia Giorgio Levi Cases", established on the basis of a specific legacy, has the institutional aim of improving and circulating know-how in the field of economics and technology of energy sources, both renewable and conventional, and their transformation and utilization, considering the impact on the environment and on the economic development.
4.b	Risorse personale
	[professori ordinari, associati, ricercatori e dottorandi, borsisti post dottorato, assegnisti, personale tecnico-amministrativo] Full professors Roberto Caldon Lorenzo Fellin Associate professors Roberto Turri Researchers Roberto Benato Arturo Lorenzoni PhD students Maurizio Albano Fabrizio Rossetto Andrea Stocco Federico Moro Fabio Bignucolo Laura Segafredo

	Laura Bano …….. External collaborators Matteo Pittarello Edoardo Pinton …..
5.b	Risorse finanziarie [media quinquennale]
	[la somma di finanziamento ordinario d'Ateneo finanziamenti specifici d'ateneo, finanziamenti specifici da enti di ricerca locali, nazionali e internazionali, finanziamenti da contratti con enti privati.] European funds: 300.000 Euro (3 years project) Institutional national funds: 230.000 Euro (average 46.000 per year) Research contracts: 390.000 Euro (average 78.000 per year)
6	Laboratori e strumentazione
	The research activity of the Group is mainly focused on power system analysis and simulation, thus the main lab equipment is represented by computer hardware and software facilities in addition to some instrumentation for on-site measurements, namely <u>Hardware</u> Several workstations which are continuously up-graded (on average every 2 years) <u>Software</u> EUROSTAG - A commercial software package for power system static and dynamic analysis Neplan – A commercial software package for power system static and dynamic analysis DigSilent - A commercial software package for power system static, dynamic and transient analysis PSCAD - A commercial software package for power system transient analysis Matlab, Simulink, Simpower EMTP <u>Instrumentation</u> TOPAS – Power Quality analyser ……. CALIFORNIA - Programmable AC/DC Source Analyser PMM - Electromagnetic field analyser

7	Rapporti con altri istituti di ricerca a livello locale, nazionale e internazionale
7.a	*[specificare concretamente quanto indicato sotto collaborazioni istituzionalizzate indicate al punto 1 della scheda di Dipartimento]* ▪ CESI Ricerca S.p.A. (Centro Elettrotecnico Sperimentale Italiano) - Milano ▪ Faculdade SATC – Criciùma – Santa Catarina – Brasil ▪ Nell'ambito del Prin '01: Università di Genova, Bologna, Cagliari, Cassino, Catania, Palermo, Pisa, Roma, Politecnici di Torino. ▪ Nell'ambito del PRIN'02: Università di Salerno, Bari, Genova, Politecnici di Bari, Milano, Torino. ▪ Nell'ambito PRIN '04 : Università di Pisa, Bologna, Cassino, Cagliari, Napoli II, Genova, Catania e Politecnici di Bari, Torino.
7.b	*[Indicare collaborazioni personali non istituzionalizzate ma rilevanti per il programma]* ▪ GRAZ University of Technology; ▪ GRTN and TERNA (Italian Transmission System Operator) ▪ TIWAG-Netz AG (Tyrol Transmission System Operator); ▪ IEFE Università Bocconi in Milano ▪ Prysmian srl (former PIRELLI); ▪ High Voltage SVEPPI Laboratory; ▪ LA.T.I.F Technological Laboratory; ▪ Physics Department, University of Swansea (UK), prof A.J.davies ▪ School of Engineering, University of Cardiff (UK), dr. M.Haddad and H.Griffiths ▪ Instituto de Investigacion Tecnologica Pontificia Universidad Comillas, Madrid ▪ GRJM Team at ADIS Research Center University Paris Sud, Department of Applied Economics Cambridge University ▪ Lund University, Warwick Business School, Energy Policy and Energy Systems Fraunhofer Institute for Systems and Innovation Research, Karlsruhe ▪ Scuola S. Anna in Pisa ▪ ENI Corporate University in Milano ▪ Politecnico di Milano ▪ Venice International University.
9	Altre attività rilevanti per la ricerca, a livello di Programma
	[organizzazione di seminari e convegni, partecipazione a seminari e convegni, ecc..] ▪ Participation to CIGRÉ WG B1.08 "Cable systems in multipurpose or shared structures" ▪ Participation to CIGRÉ Joint WG B3-B1.09 "Application of Long High Capacity Gas-Insulated Lines in Structures" ▪ Participation to IEEE PES Substations Committee. ▪ Participation to CEI SC 106-A "Esposizione umana a campi elettromagnetici a bassa frequenza" ▪ Steering Committee (section "Power generation supply and renewable resources") of the 10th Mediterranean Electrotechnical Conference (MELECON'2000), Ciprus 29-31 may 2000. ▪ International Committee della XIII International Conference on Gas Discharges (GD2000), Glasgow 3-8 settembre 2000. ▪ Permanent Steering Committee of UPEC (International Universities Power

Engineering Conference).
- Consiglio Nazionale AEE, participating to the Federation AEIT.

Organization of AEI Seminar"Elettrodotti e Territorio", Padova, 22/112000

Organization of Centro Levi Cases Seminars:
- "Energia ecosotenibile per I mezzi di trasporto: produzione di combustibili da fonti rinnovabili", Padova 18/03/2005
- "Nuove opportunità nella generazione distribuita di energia elettrica", Padova, 21/03/2005
- "Liberalizzazione nei mercati delle public utilità in Italia: effetti distributivi e consumi delle famiglie", Padova, 6/05/2005
- "Fonti rinnovabili 2005: una nuova era per il fotovoltaico", Padova, 11/11/2005
- La luce, il calore, il motore: fonti energetiche per industria, ricerca e società", Padova, 9/12/2005

Organization of Seminar "Energia&Sviluppo: Nuove prospettive e opportunità nel settore industriale", Amaro (Udine), 15/12/2004

Co-organization of Seminar "L'impatto elettromagnetico di linee ad alta tensione sul territorio: una soluzione operativa", Vigonza (Padova), 15/5/2005

Co-organization of Seminar "Campi Elettromagnetici e Politiche di Prevenzione", Padova, 3/12/2005

……..Organizzazione seminari…….

11	Prodotti della ricerca
11.b	*[per ogni anno del quinquennio la quantità totale dei prodotti del programma secondo la tipologia CINECA, indicare anche eventuali prodotti che non rientrano in questa tipologia.]*

For a datailed list of pubblications see the attached file

Project 1

RESEARCH PRODUCTS						
	2001	**2002**	**2003**	**2004**	**2005**	**Total**
Journal papers			2			2
Chapters in book						
Books/Notes/Reports				4	4	8
Proceedings of Conferences	6	2	2	4	4	18
Patents						
Other						

Project 2

RESEARCH PRODUCTS						
	2001	**2002**	**2003**	**2004**	**2005**	**Total**
Journal papers					1	1
Chapters in book						
Books/Notes/Reports						
Proceedings of Conferences			2		2	4
Patents						
Other						

Project 3

RESEARCH PRODUCTS						
	2001	**2002**	**2003**	**2004**	**2005**	**Total**
Journal papers	4	2	1		5	12
Chapters in book						
Books/Notes/Reports			4	6	8	18
Proceedings of Conferences	6	1	2	2	4	15
Patents						
Other						

Project 4

RESEARCH PRODUCTS						
	2001	**2002**	**2003**	**2004**	**2005**	**Total**
Journal papers	1			4		5
Chapters in book						
Books/Notes/Reports						
Proceedings of Conferences				1		1
Patents						
Other						

Project 5

RESEARCH PRODUCTS						
	2001	**2002**	**2003**	**2004**	**2005**	**Total**
Journal papers					1	1
Chapters in book						
Books/Notes/Reports					2	2
Proceedings of Conferences	1	2	2	2	3	10
Patents						
Other						

Project 6

RESEARCH PRODUCTS						
	2001	**2002**	**2003**	**2004**	**2005**	**Total**
Journal papers	1	1	3		1	6
Chapters in book	1		2	1	1	5
Books/Notes/Reports		1	1	2	1	5
Proceedings of Conferences	1	1	2	1		5
Patents						
Other						

11.c *[indicare i prodotti più rappresentativi con un massimo di 5 per l'intero quinquennio]*

[1] - R. Caldon.; F. Rossetto; A. Scala : "Reactive power control in distribution networks with dispersed generators: a cost based method", Electric Power Systems Research", Electric Power System Research, Elsevier, vol. 64, March, 2003, pp. 209-217.

[2] R. Benato, E. M. Carlini, C. Di Mario, L. Fellin, A. Paolucci, R. Turri: Gas Insulated Transmission Lines in Railway Galleries, *IEEE Trans. on Power Delivery,* Vol. 20, Issue 2, April 2005, pp. 704-709.

[3] R. Benato, A. Paolucci, R. Turri: Insulated Ground Wire Capacitive Currents for Tower Discharge Warning Lamp Supplying, *Electric Power Systems Research*, Vol. 71/3 Novembre 2004, pp. 211-221.

[4] M.Guarnieri, F.Moro, R.Turri:" An Integral Method for ELF Magnetic Shieldings", IEEE Transactions on Magnetics, Vol. 41 No. 5, IEEE Inc., New York (NY USA), maggio 2005, pp. 1376-1379.

[5] A. Lorenzoni, The Italian Green Certificates Market between uncertainty and opportunities, Energy Policy Volume 31, Issue 1 pp. 33-42, January 2003.

P.S. Nel caso in cui le informazioni disponibili non siano compatibili con il presente modulo è possibile allegare documentazione cartacea indicando negli appositi campi i numeri dei relativi allegati.