

*Curriculum Vitae*

**PAULO MANUEL CADETE FERRÃO**

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# PAULO MANUEL CADETE FERRÃO

## Biography

Born May 31<sup>st</sup>, 1962 in Lisbon, Portugal. Portuguese citizen. Married with two children.

## Education

### Engineering

- 2004 Habilitation in *Mechanical Engineering* in the field of *Industrial Ecology*. Instituto Superior Técnico - University of Lisbon.
- 1992 PhD in Mechanical Engineering, Instituto Superior Técnico - University of Lisbon. Thesis: "Experimental analysis of turbulent recirculating flames".
- 1987 MSc in *Energy Transfer and Energy Technologies*, Instituto Superior Técnico - University of Lisbon. Thesis: "Fluidized bed combustion of Portuguese coal".
- 1985 *Mechanical Engineer*, specialization in *Applied Thermodynamics*, Instituto Superior Técnico - University of Lisbon.

### Management

- 1988 Post-graduation in *Strategic management in a context of innovation*, CIDECE, ISCTE - University Institute of Lisbon. (Curso para especialistas: "Estratégias empresariais num contexto de inovação").

## Principal Professional Activities

### Portugal:

- 2010 - ... Full professor of the Department of Mechanical Engineering, IST - Instituto Superior Técnico - University of Lisbon.
- 2021- ... High Level Representative (HLR) of Portugal in Eureka
- 2021 - ... President of IN<sup>+</sup>, Center for Innovation, Technology and Policy Research, (<http://in3.dem.ist.utl.pt>)
- 2016-2019 President of the board of directors, Fundação para a Ciência e a Tecnologia, (Portuguese National Science and Technology Foundation).
- 2010-2014 Member of the Board of Directors, Oeineerg - Oeiras Municipality Energy Agency. (<http://www.oeinerge.pt>)
- 2009-2014 Member of the Board of Directors, Competitiveness and Technology Cluster for Energy – EnergyIn. (<http://www.energyin.com.pt/index.php?lang=en>)
- 2006-2016 Director, MIT-Portugal Program (<http://www.mitportugal.org>).

### Europe:

- 2022-... Deputy- Chair of the European Commission Mission Board on “Climate-Neutral and Smart Cities”
- 2021-... Member of the Executive Board of the EUREKA Association, <https://www.eurekanetwork.org>
- 2019-2021 Member of the European Commission Mission Board on “Climate-Neutral and Smart Cities”
- 2015-... Member of the Environmental Advisory Committee of Rolls Royce.
- 2019-2021 President of COST (European Cooperation in Science & Technology) Association, <https://www.cost.eu>.
- 2016-2019 President of the Board, INL -International Iberian Nanotechnology Laboratory, <https://inl.int>.
- 2016-2019 Member of the Governing Board, JRC – Joint Research Centre, [https://ec.europa.eu/info/departments/joint-research-centre\\_en](https://ec.europa.eu/info/departments/joint-research-centre_en).
- 2016-2019 Member of the Council, ESA - European Space Agency, <https://www.esa.int>.

- 2016-2019 Member of the Council, ESO - European Southern Observatory, <https://www.eso.org/public/>.
- 2007 Chairman, “EFDA (European Fusion Development Agreement) Ad-Hoc Group on Socio-Economics”, appointed to promote an assessment of the EFDA SERF (Socio-Economic Research on Fusion) and propose recommendations for a future research agenda in EU-FP7.

#### USA:

- 2013-2018 Member, U.S. National Academies Roundtable on Science and Technology for Sustainability. The National Academies of Sciences, Engineering and Medicine, U.S.A.
- 2015-2016 Member, Committee on Pathways to Urban Sustainability: Challenges and Opportunities for the United States. The National Academies of Sciences, Engineering and Medicine, U.S.A.
- 2011-2013 Member, Committee on Sustainability Linkages in the Federal Government, The National Academies of Sciences, Engineering and Medicine, U.S.A.

### **University Appointments**

- 2010 - ... Full professor of the Department of Mechanical Engineering, IST - Instituto Superior Técnico - University of Lisbon.
- 2006-2016 Research Scholar at MIT - Massachusetts Institute of Technology, USA.
- 2010-2016, 2020 - ... Director of the IST Energy Initiative.
- 2010-2016 Coordinator of the “Sustainable Energy Systems for Renewables” track of the European Institute of Innovation & Technology doctoral program on “Sustainable Energy”. (<http://eit.europa.eu/education/kic-doctoral-programmes/>)
- 2008-2016 Head, “Environment and Energy” Section of the Mechanical Engineering Department, IST.
- 2008-2016 Member, Senate of the Mechanical Engineering Department, IST.
- 2007-present Research Affiliate, MIT-Massachusetts Institute of Technology.
- 2007-2016 Coordinator, Doctoral Program on “Sustainable Energy Systems”, IST.
- 2007-2016 Coordinator, Executive Program on “Sustainable Energy Systems”, IST.
- 2013-2015 President, Scientific Council of the Center for Innovation, Technology and Policy Research, IN<sup>+</sup>. (<http://in3.dem.ist.utl.pt>).
- 2005-2012 President, Center for Innovation, Technology and Policy Research, IN<sup>+</sup>. (<http://in3.dem.ist.utl.pt>)
- 2001-2010 Associate professor, IST.
- 2009-2010 Member, Scientific Council, IST.

- 2005-2006 Head, “Environment and Energy” Section of the Mechanical Engineering Department, IST.
- 2005-2006 Coordinator, MSc Program on “Engineering Design”, IST.
- 2003-2005 Deputy director, Center for Innovation, Technology and Policy Research, IN+.
- 1999-2006 Coordinator, International Student Exchange Programs at the Mechanical Engineering Department, IST.
- 1999-2000 Member, Pedagogical Council, IST.
- 1998-2003 Board member, Center for Innovation, Technology and Policy Research, IN+.
- 1993-2001 Assistant Professor, IST.
- 1985-1993 Teaching Assistant, IST.

## **Selected Governmental Advisory Activities**

### Portugal

- 2021 Coordinator of the study “Energy Storage in Portugal”, available at <https://www.observatoriodaenergia.pt/pt/comunicar-energia/post/8931/armazenamento-de-energia-em-portugal/>
- 2020-2021 Technical Coordinator, taskforce for defining a strategy for waste to contribute to the decarbonization of the Portuguese economy.
- 2013-2014 Coordinator, “Portuguese Strategic Plan for Urban Waste Management - 2020”. Ministry for the Environment, Spatial Planning and Energy.
- 2011-2014 Coordinator, “Portuguese Strategy for Waste Management: 2011-2020”. Ministry for the Environment, Spatial Planning and Energy.
- 2010-2014 Portuguese representative at the Steering Group of the European Strategic Energy Technology Plan, European Union SET-Plan. Ministry for Education and Science. ([http://ec.europa.eu/energy/technology/set\\_plan/set\\_plan\\_en.htm](http://ec.europa.eu/energy/technology/set_plan/set_plan_en.htm))
- 2011-2013 Member, Standing Bilateral Commission USA-Portugal, representing the Minister of Science. Ministry of Foreign Affairs.
- 2004 Coordinator, Ministry of Economy committee created to contribute to the National Sustainable Development Strategy.

### OECD- Organisation for Economic Co-operation and Development

- 2005-2006 Member, Steering group of the Project on “Global Infrastructure Needs: Prospects and Implications for Public and Private Actors” that resulted in the report: “Infrastructure to 2030: Main Findings and Policy Recommendations “. (<http://www.oecd.org/futures/infrastructureto2030/40953164.pdf>)

## **Professional Societies and Associations**

- Member of the International Society for Industrial Ecology (ISIE)
- Member, Portuguese Society of Engineers (OE)

# 1 RESEARCH

## *1.1 Current Research Interests and Profile*

### **Industrial ecology methods and tools**

My research interests in industrial ecology tools and methods are broad, covering the whole field. I started with Life Cycle Assessment and I aimed at extending the existing tools to other dimensions. I worked in combining LCA with the classical economics formulation of activity analysis in order to pioneer a new method, Life Cycle Activity Analysis. I have also worked on EIO (Economic Input-Output) extensions of LCA, resulting on hybrid EIO-LCA methods. Aiming to characterize the metabolism of economies and to support a new approach to industrial symbiosis, I developed work on MFA (Material Flow Analysis). In order to have a direct practical impact on industrial operations, I engaged in fieldwork to get the empirical data on the performance of industrial facilities and to develop models for characterizing end-of-life processing operations and full infrastructures, with particular emphasis on materials recovery. In Portugal, I have coordinated the design of most of the Producer Responsible Organizations that are responsible for EoL processing of products namely for vehicles, electric and electronic products, batteries or tyres.

Energy planning models are also part of my research agenda due to the critical relevance of renewable energy sources for the design of sustainable energy systems. I have been particularly involved in developing and applying novel enhancements in the time resolution of energy planning tools to underpin strategies to support the design of energy systems to accommodate the variability inherent in many renewable energy sources.

### **The metabolism of the economy - contributions to a green business agenda**

My research focus on the metabolism of the economies brought a stronger analytical basis to discussions on why dematerialization is not occurring, considering that direct material input (DMI) per capita is positively correlated with gross domestic product per capita, and this developed into significant research on how business models could incorporate environmental concerns and develop green agendas. A direct application of this research has been in designing the Portuguese national plans for waste management. Another particular focus was given to the automobile sector and on the development of new business approaches that would optimize the environmental and economic dimensions of materials recovery at end-of-life. I have also been contributing to the ecodesign of automotive components, particularly through the incorporation of natural fibers in composite materials.

### **Urban Metabolism**

I am developing a digital twin for cities, to model, with the spatial resolution of a building, the energy consumption, the renewable energy generation and the material circularity dynamics in order to advance the energy transition required to promote carbon-neutral cities and a circular economy. I am focused on research to advance the state of the art of urban metabolism as a guiding framework for urban development, making use of industrial ecology principles, by establishing a robust and standard method to quantify the urban metabolism of cities across the world, so that one may use compatible data sources and material types, to derive policies to promote resource efficiency and sustainable growth pathways.

## Research Profiles:

ResearcherID: B-6065-2012

Scopus Author ID: 6603743982

Ciência ID: 0E10-1B27-AFB7

ORCID: <https://orcid.org/0000-0003-1357-9966>

## 1.2 Books

1. Katchi, L. et al (2016) “Pathways to Urban Sustainability: Challenges and Opportunities for the United States”, The National Academies Press – Washington. ISBN-13: 978-0-309-44453-8, DOI: <https://doi.org/10.17226/23551>, 192 pages.
2. Paulo Ferrao, João Fumega, Nuno Gomes, Samuel Niza, André Pina and Luis Santos (2014), “Urban metabolism of six Asian cities”, Asian Development Bank ADB.
3. Paulo Ferrão and John Fernandez (2013) “Sustainable Urban Metabolism”, MIT-Press. ISBN: 9780262019361, 232 pages.
4. Graedel et al. (2013) “Sustainability for the Nation: Resource Connection and Governance Linkages”. The National Academies Press - Washington. ISBN: 978-0-309-26230-9, 142 pages.
5. Paulo Ferrão (2009) “Industrial ecology: principles and tools”. IST-Press, 422 pages. ISBN 978-972-8469-75-5. (In Portuguese).
6. Paulo Ferrão, Paulo Ribeiro e Paulo Silva (2005) “Industrial Ecology and Food packaging in Portugal”. Celta Editores, 441 pages. ISBN: 972-774-213-0. (In Portuguese).
7. José Camacho, Paulo Ferrão e Cruz Rodrigues/Bago d’Uva, editors. (2004) “Portuguese Automotive Industry: Exploring new paths, the challenge of auto interiors”. INFORFI, 200 pages. (In Portuguese).
8. Paulo Ferrão e José Figueiredo, editors. (2000) “Industrial Ecology and the Automobile in Portugal”. Celta Editora, 268 pages. ISBN: 972-774-092-8. (In Portuguese).
9. Paulo Ferrão (1998) "Introduction to Environmental management: Life Cycle Assessment". Coleção Ensino da Ciência e Tecnologia. IST-Press, 219 pages. ISBN: 972-8469-05-05. (In Portuguese).



### 1.3 *Scientific Papers*

1. S Cunha, P Ferrão (2023) “A New Framework for Circular Refurbishment of Buildings to Operationalize Circular Economy Policies”. *Environments* 10 (3) 51.
2. “Selection of a CO<sub>2</sub> capture technology for the cement industry: An integrated TEA and LCA methodological framework”. *Journal of CO<sub>2</sub> Utilization* 68, 102375.
3. J Fernandes, and P Ferrão (2023) “Urban Metabolism-Based Approaches for Promoting Circular Economy in Buildings Refurbishment”. *Environments* 10 (1) 13.
4. R He, M Sandoval-Reyes, I Scott, R Semeano, P Ferrao, S Matthews (2022) “Global knowledge base for municipal solid waste management: Framework development and application in waste generation prediction”. *Journal of Cleaner Production* 377, 134501.
5. Cunha, P. Ferrão (2022) “ Can structural changes lead to dematerialization? Lessons from the Portuguese socioeconomic metabolism between 1995 and 2017”. *Resources, Conservation and Recycling*, 180, 106169
6. J Henriques, P Ferrão, M Iten (2022) “Policies and Strategic Incentives for Circular Economy and Industrial Symbiosis in Portugal: A Future Perspective”. *Sustainability*, 14, (11), 6888
7. S. Cunha and P. Ferrão (2021) “A framework to analyze the dynamics of the socioeconomic metabolism of countries: A Portuguese case study”. *Journal of Industrial Ecology*, 1 – 14. (DOI: 10.1111/jiec.13184)
8. I Andrić, O Le Corre, B Lacarrière, P Ferrão, SG Al-Ghamdi (2021). “Initial approximation of the implications for architecture due to climate change”. *Advances in Building Energy Research* 15 (3), 337-367
9. J. Henriques, P. Ferrão, R. Castro and J. Azevedo (2021). “Industrial Symbiosis: A Sectoral Analysis on Enablers and Barriers”. *Sustainability*, vol 13, 1723. (<https://doi.org/10.3390/su13041723>)
10. W. Liu, P. Ford, H. Uvegi, F. Margarido, E. Santos, P. Ferrão, E. Olivetti (2019). “Economics of materials in mobile phone preprocessing, focus on non-printed circuit board materials”. *Waste management*, vol. 87, pp. 78-85.
11. K. Benis, I. Turan, C. Reinhart, P. Ferrão (2018). “Putting rooftops to use – A Cost-Benefit Analysis of food production vs. energy generation under Mediterranean climates”. *Cities*, vol. 78, pp. 166-179.
12. K. Benis and P. Ferrão (2018). “Commercial farming within the urban built environment – Taking stock of an evolving field in northern countries”. *Global Food Supply*, vol. 17, pp. 30-37.

13. L. Barbosa, P. Ferrão, A. Rodrigues, A. Sardinha (2018). “Feed-in tariffs with minimum price guarantees and regulatory uncertainty”. *Energy Economics*, vol. 72, pp. 517, 541.
14. I. Andric, J. Fournier, B. Lacarrier, O. Le Corré, P. Ferrão (2018). “The impact of global warming and building renovation measures on district heating system techno-economic parameters”. *Energy*, vol. 150, pp.926-937.
15. Cláudia Sousa Monteiro, Carlos Costa, André Pina, Maribel Santos and Paulo Ferrão “An Urban Building Database (UBD) supporting a Smart City Information System” (2018) *Energy and Buildings*, vol. 158, pp. 244-260.
16. J Aleluia, P Ferrão (2017) Assessing the costs of municipal solid waste treatment technologies in developing Asian countries. *Waste Management* 69, 592-608
17. I. Andric, A Pina, P Ferrão, J Fournier, B Lacarrière, O. Le Corre (2017). “The impact of climate change on building heat demand in different climate types”. *Energy and Buildings*, vol. 149, pp 225-234.
18. Andrić, I., Pina, A., Ferrão, P., Lacarrière, B., Le Corre, O. (2017).” Assessing the feasibility of using the heat demand-outdoor temperature function for a long-term district heat demand forecast”. *Energy Procedia*, vol.116, pp- 460-469.
19. Benis, K. Reinhart, C. and Ferrão, P. (2017).” Development of a simulation-based decision support workflow for the implementation of Building-Integrated Agriculture (BIA) in urban contexts”. *Journal of Cleaner Production*, vol. 147, pp. 589-602
20. Sousa Monteiro, C., Pina, A., Cerezo, C., Reinhart, C. and Ferrão, P. (2017). “The Use of Multi-detail Building Archetypes in Urban Energy Modelling”. *Energy Procedia*, vol. 111, pg. 817-825.
21. Andrić, I., Pina, A., Ferrão, P., Lacarrière, B., Le Corre, O. (2017). “On the performance of district heating systems in urban environment: an emergy approach”. *Journal of Cleaner Production*, vol. 142, pp. 109-120.
22. Benis, K. and Ferrão, P. (2017). “Potential mitigation of the environmental impacts of food systems through urban and peri-urban agriculture (UPA) – a life cycle assessment approach”. *Journal of Cleaner Production*, vol. 140(2), pp. 784-795.
23. Matos, M. and Ferrão, P. (2017). “Sustainable Energy Campus: A Challenge on Smart Facilities and Operations”. *Handbook of Theory and Practice of Sustainable Development in Higher Education - World Sustainability Series*, pp 241-255.
24. Gomes, R., Pombeiro, H., Silva, C., Carreira, P., Carvalho, M., Almeida, G., Domingues, P. and Ferrão, P. (2017). “Towards a Smart Campus: Building-User Learning Interaction for Energy Efficiency, the Lisbon Case Study”. *Handbook of Theory and Practice of Sustainable Development in Higher Education - World Sustainability Series*, pp 381-398.

25. Aleluia, J. and Ferrão, P. (2016). “Characterization of urban waste management practices in developing Asian countries: A new analytical framework based on waste characteristics and urban dimension”. *Waste Management*. doi:10.1016/j.wasman.2016.05.008.
26. Andrić, I., Gomes, N., Pina, A., Ferrão, P., Fournier, J., Lacarrière, B., Le Corre, O. (2016). “Modeling the long-term effect of climate change on building heat demand: case study on a district level”. *Energy and Buildings*, vol. 126, pp. 77-93.
27. Ford, P., Santos, E., Ferrão, P., Margarido, F., Van Vliet, K. and Olivetti, E. (2016). “Economics of End-of-Life Materials Recovery: A Study of Small Appliances and Computer Devices in Portugal”. *Environmental Science and Technology*, **2016**, 50 (9), pp 4854–4862. DOI: 10.1021/acs.est.6b00237.
28. Monit., M., Pina, A. and Ferrão, P. (2016) “Linking Material Flow Analysis with Resilience Using Rice: A Case Study in Global, Visual MFA of a Key Food Product”. *Resources*, 5, 4; doi: [10.3390/resources5010004](https://doi.org/10.3390/resources5010004)
29. Rodrigues, J., Lorena, A., Costa, I., Ribeiro, P. and Ferrão, P. (2016) “An input-output model of extended producer responsibility”. *Journal of industrial ecology*, pp. 1-11.
30. Pina, A., Ferrão, P., Ferreira, D., Santos, L., Rodrigues, J. and Niza, S. (2016) “The physical structure of urban economies - Comparative assessment”. *Technological Forecasting & Social Change*, 111, pp.220-229.
31. Lagarto, J., Sousa, J.A.M, Martins, A., Ferrão, P. (2014) “Market power analysis in the Iberian electricity market using a conjectural variations model”. *Energy*, 76, pp. 292-305.
32. Gerbelová, H., Amorim, F., Pina, A., Melo, M., Ioakimidis, C., Ferrão, P. (2014) “Potential of CO<sub>2</sub> (carbon dioxide) taxes as a policy measure towards low-carbon Portuguese electricity sector by 2050”. *Energy*, 69, pp. 113-119.
33. Rosado, L., Niza, S., Ferrão, P. (2014) “A Material Flow Accounting Case Study of the Lisbon Metropolitan Area using the Urban Metabolism Analyst Model”. *Journal of Industrial Ecology*, 18, pp.84-101.
34. Ferrão, P., Ribeiro, P., Rodrigues, J., Marques, A., Preto, M., Amaral, M., Domingos, T., Lopes, A., Costa, I. (2014). “Environmental, economic and social costs and benefits of a packaging waste management system: A Portuguese case study”. *Resources, Conservation and Recycling*, 85, pp. 67-78.
35. Pina, A., Baptista, P., Silva, C., Ferrão, P. (2014) “Energy reduction potential from the shift to electric vehicles: The Flores island case study”. *Energy Policy*, 67, pp. 37-47.
36. Niza, S., Santos, E., Costa, I., Ribeiro, P., Ferrão, P. (2014) “Extended producer responsibility policy in Portugal: a strategy towards improving waste management performance”. *Journal of Cleaner Production*, 64, pp. 277-287.

37. Cardoso, G., Stadler, M., Bozchalui, M.C., Sharma, R., Marnay, C., Barbosa-Póvoa, A., Ferrão, P. (2014) “Optimal investment and scheduling of distributed energy resources with uncertainty in electric vehicle driving schedules”. *Energy*, 64, pp 17-30.
38. Cardoso, G., Stadler, M., Bozchalui, M.C., Sharma, R., Marnay, C., Barbosa-Póvoa, A., Ferrão, P. (2013) “Stochastic Programming of Vehicle to Building Interactions with Uncertainty in PEVs Driving for a Medium Office Building”. *Proceedings of the IECON 2013 - 39th Annual Conference of the IEEE. Industrial Electronics Society*, pp. 7648-7653.
39. Pina, A., Silva, C. and Ferrão, P. (2013) “High-resolution modeling framework for planning electricity systems with high penetration of renewables”, *Applied Energy*, 112, pp. 215-223.
40. Cardoso, G., Stadler, M., Siddiqui, A., Marnay, C., DeForest, N., Póvoa, A., Ferrão P. (2013) “Microgrid reliability modeling and battery scheduling using stochastic linear programming”. *Electric Power Systems Research*, 103, pp. 61-69.
41. Suomaleinen, K., Silva C., Ferrão P. and Connors S. (2013) “Wind power design in isolated systems: Impacts of daily wind patterns”. *Applied Energy*, 101, pp. 533-540.
42. Gerbelová, H., Vesteeeg P., Ioakimidis C., Ferrão P. (2013) “The effect of retrofitting Portuguese fossil fuel power plants with CCS”. *Applied Energy*, 101, pp. 280-287.
43. Ferrão, P. and Silva C. (2012) “Change in the energy systems paradigm and the impact on regional development”. In: *Networks, Space and Competitiveness-Evolving challenges for sustainable growth*, edited by R. Capello and T. Dentinho, Edward Elgar, pp. 56-76.
44. Pina, A., Silva C., Ferrão P. (2012) “The impact of demand side management strategies in the penetration of renewable electricity”. *Energy*, 41, pp.128-137.
45. Abreu, J., Pereira J.C., Ferrão P. (2012) “Using pattern recognition to identify habitual behavior in residential electricity consumption”. *Energy and Buildings*, 49, pp. 479-487.
46. Suomalainen, K., Silva C., Ferrão P., Connors S. (2012) “A method for including daily patterns to synthetic wind speed data for energy systems planning: Validation in the Azores Islands” *Journal of Renewable and Sustainable Energy*, 4-2, pp. 023102-023102-15.
47. Suomalainen, K., Silva C., Ferrão P. and Connors S. (2012) “Synthetic wind speed scenarios including diurnal effects: Implications for wind power dimensioning”, *Energy*, 37, pp. pp 41-50.
48. Mendes, G., Ioakimidis C., Ferrão P. (2011) “On the planning and analysis of Integrated Community Energy Systems: A review and survey of available tools”. *Renewable & Sustainable Energy Reviews*, 15 - 9, pp. 4836-4854.
49. Pina, A., Silva C. and Ferrão P. (2011) “Modeling hourly electricity dynamics for policy making in long-term scenarios”. *Energy Policy*, 39 - 9, pp. 4692–4702.

50. Wiesmann, D., Azevedo I., Ferrão P., Fernandez J. E. (2011) “Residential electricity consumption in Portugal: Findings from top-down and bottom-up models”. *Energy Policy*, 39, pp. 2772–2779.
51. Ioakimidis, C., Gerbelova H., Casimiro S., Chatzimichali A., Ferrão P. (2011) “A Qualification study and assessment of the CO<sub>2</sub> storage capacity, siting and costs in Portugal” *Energy Procedia: 10th Conference on greenhouse gas control technologies*. Volume 4, pp. 3087-3094. Editors: Gale, J; C. Hendriks and W. Turkenberg.
52. Gerbelova H., Ioakimidis C., Ferrão P. (2011) “A techno-economical study of the CO<sub>2</sub> capture in the energy sector in Portugal” *Energy Procedia: 10th Conference on greenhouse gas control technologies*. Volume 4, pp. 1965-1972. Editors: Gale, J; C. Hendriks and W. Turkenberg.
53. Gerbelova H., André A., Casimiro S., Melo M., Ferrão P. (2011) “Assessment of Carbon Capture and Storage Opportunities: Portuguese Case Study” *Energy Procedia: 10th Conference on greenhouse gas control technologies*. Volume 4, pp. 6109-6116. Editors: Gale, J; C. Hendriks and W. Turkenberg.
54. Alves, C., Dias A., Diogo A., Ferrão P., Luz S., Silva A., Reis L. and Freitas M. (2010) “Eco-Composite: the effects of the superficial treatments of jute fibers on the mechanical and environmental performance of the composite materials”. *Journal of Composite Materials*, 45-5, pp. 573-589.
55. Luz S.M., Gonçalves, A. R., DelÁrco, A. P., Leão, A. L., Ferrão, P., Rocha, G.J. (2010) “Thermal Properties of Polypropylene Composites Reinforced with Different Vegetable Fibers”. *Advanced Materials Research*, 123-125, pp. 1199-1202.
56. Luz S.M., Caldeira-Pires, A., Ferrão, P. (2010) “Environmental benefits of substituting talc by sugarcane bagasse fibers as reinforcement in polypropylene composites: Ecodesign and LCA as strategy for automotive components”. *Resources, Conservation and Recycling*, 54, pp. 1135–1144.
57. Alves C., Ferrão, P., Silva, A. J., Reis, L.G., Freitas M., Rodrigues L.B., Alves, D.E. (2010) “Ecodesign of automotive components making use of natural jute fiber composites”. *Journal of Cleaner Production*, 18 - 4, pp. 313-327.
58. Luz S.M., Ferrão, P., Alves, C., Freitas, M., Caldeira-Pires A. (2010) “Ecodesign Applied to Components Based on Sugarcane Fibers Composites”. *Materials Science Forum*, 636-637, pp. 226-232.
59. Costa I. and Ferrão, P. (2010) “A case study of industrial symbiosis development using a middle-out approach”. *Journal of Cleaner Production*, 18 -10, pp. 984-992.
60. Niza S., Rosado L. and Ferrão, P. (2009) “Urban Metabolism: Methodological advances in Urban Material Flow Accounting based on the Lisbon case study”. *Journal of Industrial Ecology*, 13 – 3, pp. 384-405.

61. Panão M J.N.O., Gonçalves H. J. P., Ferrão P. (2009) “Numerical analysis of the street canyon thermal conductance to improve urban design and climate”. *Building and Environment*, 44 -1, pp. 177-187.
62. Ferrão P. and Nhambiu, J. (2009) “A comparison between conventional LCA and Hybrid EIO-LCA: Analyzing crystal giftware contribution to global warming potential”. In: *Handbook of Input-Output Economics in Industrial Ecology*, pp. 219- 230. Edited by Sangwon Suh. Springer.
63. Alves C., Ferrão, P., Freitas, M., Silva A.J., Luz, S.M., Alves, D.E. (2009) “Sustainable Design Procedure: the role of composite materials to combine mechanical and environmental features for agricultural machines”. *Materials and Design*, 30 - 10, pp. 4060-4068.
64. Leão A.L., Ferrão, P., Souza, S.F. (2009) “State of the art for extrusion and injection molding FPC: natural Fiber Plastics Composites in Brazil” *International Journal of Materials and Product Technology*, 36 - 1, pp. 134-154.
65. Ferrão P., Ribeiro, P. and Silva, P. (2008) “A management system for end-of-life tyres: the Portuguese case study”. *Waste Management*, 28 -3, pp. 604-614.
66. Panão M J., Gonçalves, H., Ferrão, P. (2008) “Optimization of the urban building efficiency potential for mid latitude climates using a genetic algorithm approach”. *Renewable Energy*, 33-5, pp. 887-896.
67. Luz S.M., Gonçalves, A.R., del’Arco A.P., Ferrão, P. (2008) “Composites from Brazilian natural fibers with polypropylene: mechanical and thermal properties”. *Composite Interfaces*, 15 - (7 -9), pp. 841–850.
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71. Ferrão P. (2007) " Industrial ecology: a step towards sustainable development". In: *A Portrait of State-of-the-Art Research at the Technical University of Lisbon*, pp. 357-383. Edited by M. Seabra Pereira. Springer.
72. Dijkema G.P.J., Ferrão, P., Herder P.M. and Heitor M.V. (2006) “Trends and opportunities framing innovation for sustainability in the learning society”. *Technological Forecasting and Social Change*, 73, pp. 215-227.

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#### ***1.4 Technical Reports (selected)***

- P. Ferrão et al. (2013) "Metabolism of urban areas - key Indicators for Asia and the Pacific 2011". Report to the Asian Development Bank.
- C. Dopazo et al. (2012) "An infrastructure roadmap for Uzbekistan". Paulo Ferrão was the coordinator of the "urban services sector roadmap". An Asian Development Bank project. <http://www.adb.org/sites/default/files/projdocs/2013/44402-012-reg-tacr-02.pdf>
- C. Dopazo et al. (2012) "An infrastructure roadmap for Kazakhstan". Paulo Ferrão was the coordinator of the "urban services sector roadmap". An Asian Development Bank project. <http://www.adb.org/projects/documents/preparation-sector-road-maps-central-and-west-asia-kazakhstan-tacr>
- P. Ferrão, P. Ribeiro, A. Lopes, C. Silva, G. Pereira, A. Pina (2011) "Life Cycle Assessment of the Alto Sabor Pumped-storage hydro dams system". Report to the Electricity of Portugal.
- P. Ferrão, A. Zurita, M. Quang Tran, A. Soria, G. Borrelli, and C. Ehrer (2007) "An assessment of the EFDA SERF program: future directions. A review of SERF 1997-2006 and recommendations and guidelines for a future research agenda". Report to the European Commission.
- E. Neves, A. Monteiro, M. Fonseca, M. Cruz e P. Ferrão (2007) "Design of the new Scientific, Technological and Human Resources organization of the National Institute for Engineering and Industrial Technology, in the context of its transformation in the National Laboratory for Energy and Geology". Report to the Council of Ministers of the Portuguese Government. (In Portuguese).
- P. Ferrão, J. Parente and J. Macedo (2007) "Analysis of business opportunities associated with Transforming Biomass into Energy in the islands of the Azores". Report to the Regional Government of the Azores. (In Portuguese).

- P. Ferrão, L. Rosado, S. Niza, (2007) “Materials balance for the city of Lisbon”, Report to the Energy Agency of the Lisbon Municipality.
- P. Ferrão, J. Amaral (2003) “Design of a producer responsibility organization (PRO) to manage the integrated system for End of life tires processing, for the manufacturers to assume their extended producer responsibility in Portugal” Report produced to the Association of automobiles manufacturers –ACAP.
- P. Ferrão, P. Silva, P. Ribeiro (2002) “Design of a producer responsibility organization (PRO) to manage the integrated system for End of life vehicles (ELV) processing, for the manufacturers to assume their extended producer responsibility in Portugal” Report produced to the Association of automobiles manufacturers –ACAP.
- P. Ferrão (2000) “Suppliers Within an Ecologically Aware Automotive Sector”. Report to the European Commission.

### ***1.5 Research funding: grants and contracts (selected)***

- 2020-2023 MIT-Portugal Program – Flagship project “C-TECH, Climate Driven Technologies for Low Carbon Cities”. IST Budget: 631.000 €.
- 2020-2023 CMU-Portugal Program– Flagship Project “Bee2WasteCrypto” – IST Budget: 466.000 €.
- 2006-2017 MIT-Portugal Program – Director of the Program. Overall Portuguese Budget for Portuguese Universities: 42.000.000 €.
- 2006-2016 MIT-Portugal Program – Director of the Program. Overall Portuguese Budget for Portuguese Universities: 42.000.000 €.
- 2006-2014 Portuguese Foundation for Science and Technology, Principal Investigator, “Sustainable Energy Systems Research Project - MIT-Portugal Program”. Budget: 1.413.343 €
- 2006-2012 Portuguese Foundation for Science and Technology, Principal Investigator, “Engineering Systems Research Project under the MIT-Portugal Program”. Budget: 1.768.943 €.
- 2010-2013 Portuguese Foundation for Science and Technology, Principal Investigator, “New energy systems modeling platforms for dynamic energy supply and demand on local and regional scales: Case study of building-integrated microgeneration in São Miguel, the Azores”. Budget: 107.712 €
- 2011-2012 Asian Development Bank, Principal Investigator for the urban services sector roadmap, “Preparation of Sector Road Maps for Central and West Asia”. Budget: 290.000 €

- 2007-2010 Portuguese Foundation for Science and Technology, Principal Investigator, “Development of cooperative Eco-design methods and tools applied to automotive components' design: the case study of natural fiber based composite materials”.  
Budget: 194.761 € (IST component)
- 2012-2015 Portuguese Foundation for Science and Technology, Principal Investigator, “Integrated geo-referenced model for sustainable urban metabolism”.  
Budget: 115.000 €
- 2001-2003 Ministry of Economy, Principal Investigator, “Strategies for innovative development of the Portuguese auto-interiors industry”  
Budget: 55.935 €
- 2001-2003 Ministry of Economy, Principal Investigator, “EcoTech – Strategies for the development of an eco-efficient automotive industry in Portugal”  
Budget: 185.199 €
- 2002-2003 Association of automobiles manufacturers –ACAP, Principal Investigator, “Model of the end-of-life vehicles processing infrastructure in Portugal”  
Budget: 60.853 €
- 2002-2003 Ecometais, Principal Investigator, “Techno-economic models of a shredder, including auto-shredding residues processing”  
Budget: 75.000 €
- 2003-2006 Ministry of the Environment, Principal Investigator, “Development of an integrated waste management information system for Portugal”  
Budget: 400.000 €
- 2003-2005 Ministry of Economy, Principal Investigator, “Sustainable Development strategies for Aveiro”  
Budget: 137.978 €
- 2006 Regional development agency, Principal Investigator, “Design of an Eco-Industrial Park at Chamusca, the EIP of Relvão”  
Budget: 60.000 €
- 2007-2009 Electricity of Portugal, Principal Investigator, “Life Cycle Assessment of the Alto Sabor Pumped-storage hydro dams system”  
Budget: 190.000 €

## ***1.6 Awards and Recognition***

- 2021 Awarded the title of “Distinguished IST Professor”
- 2013 Elected to the Council of the International Society for Industrial Ecology

- 2010 Appointed to Oeiras Municipality Energy Agency Board of Directors
- 2010 Elected as Director of the IST Energy Initiative.
- 2006 R&D 2006 Prize from the Portuguese Green Dot Society, awarding the contribution of the book “Industrial Ecology and Food packaging in Portugal” by P. Ferrão, P. Ribeiro and P. Silva.
- 2000 “Best paper award” SAE-Society of Automotive Engineers - Total Life Cycle Conference, April 26-28, Detroit, Michigan, USA. Paper: F. Freire, P. Ferrão, C. Reis and S. Thore (2000) “Life Cycle Activity Analysis applied to the Portuguese used tire market”.
- 2000 Advisor of the laureate for the German Engineers Society Prize “Förderpreis” to the best Final Project in Mechanical Engineering in 1999, attributed to Reinhardt Stork. He developed his final Project at IST in the context of the Socrates/Erasmus program. Awarded project: “Development strategies and technologies for End of Life Vehicles (ELV) processing in Portugal, based on the experience of the German and Dutch systems”.
- 1998 Awarded with a Window on Science (WOS) program at the U. S. Air Force Research Laboratories - Wright Patterson Air-Force Base, Ohio. This program is intended to facilitate technical interactions on fundamental research via direct contact between distinguished foreign researchers and U. S. Air Force Research Laboratory scientists and engineers.
- 1998 Awarded a visiting scientist program in the Japanese National Research Laboratory of Metrology, Tsukuba, Japan.
- 1985 Prize for the Best Mechanical Engineering graduate at IST, during the commemorations of IST 75th anniversary.

## 2 TEACHING

### 2.1 Courses taught

- 2021-Present **Energy and Sustainability**, master degree
- 2001-present **Industrial ecology**, master degree.
- 2003-present **Interdepartmental Seminars on Sustainable Development and Innovation**, graduate and undergraduate levels.
- 2007-2016 **Energy Management**, graduate and undergraduate levels.
- 2001-2004 **Economy, Energy and the Environment**, graduate level.

- 2001-2006 **Industrial Ecology and Environmental Policy**, graduate level.
- 1997-2001 **Environment, Energy and Development policies**, graduate level.
- 1995-2006 **Energy and Environment**, undergraduate level.
- 1994-1997 **Experimental Methods in Energy and Environment**, undergraduate level.
- 1994-1995 **Analysis of Energy Systems**, undergraduate level.
- 1987-1988 **Heat transfer**, undergraduate level.
- 1986-1995 **Thermodynamics**, undergraduate level.
- 1985-1986 **Applied Mechanics**, undergraduate level.

## ***2.2 Post Doctoral Associates***

- 2008-Present **Samuel Niza**, Portuguese, “Industrial Ecology – Urban Metabolism”
- 2012-Present **André Pina**, Portuguese, “Energy planning and urban metabolism quantification methods”
- 2009-2012 **Carlos Silva**, Portugal, “Sustainable energy systems”
- 2009-2010 **Sandra Luz**, Brazilian “Ecodesign applied to components based on fibers composites”
- 2008-2011 **Christos Ioakimidis**, Greek, “Sustainable energy systems”
- 2008-2009 **Sandra Luz**, Brazilian, “Ecodesign based on natural fibers composites”
- 2008-2009 **João Melo**, Portuguese, “Energy systems modeling – the role of carbon capture and sequestration”
- 2007-2008 **Eloy Casagrande**, Brazilian, “Green Design”.

## ***2.3 Current Doctoral Students – Doctoral Advisor***

- **Melissa Costa**, “The roles of green H<sub>2</sub> and CO<sub>2</sub> capture in the cement sector decarbonisation”.
- **Francisco Capucha**, “*Eco-design of Clinker and Cement*”.
- **Juan Henriques**, “Industrial Symbiosis: a strategy for circular economy”.

## ***2.4 Past Doctoral Students – Doctoral Advisor***

### Doctoral Program on Sustainable Energy Systems at IST – MIT-Portugal Program

- 2022        **Sónia Cunha**, “The metabolism of economies: methodological developments and policies for resource efficient economies”. Current Position: Leiden University
- 2018        **João Aleluia**, “Assessing the sustainability impacts of Municipal Solid Waste treatment approaches in developing Asia”. Current position: UNEP.
- 2018        **Claudia Sousa Monteiro**, “Building energy modeling at urban scale using multi-detail archetypes: addressing the uncertainties and applications”. Current position: ADENE.
- 2018        **Khadija Benis**, “Building Integrated Agriculture (BIA) in urban contexts – methodological contributions to sustainability assessment”. Current position: Researcher at MIT.
- 2018        **Gonçalo Pinto Mendes**, Design of multi-building microgrids”. Current Position: Lappeenranta – Lahti University of Technology LUT · Department of Energy
- 2017        **Ivan Andric**, “The assessment of District Heating Potential in a Context of Climate Change and building Renovation”. Current position: IE Business School, Abu Dhabi, United Arab Emirates.
- 2016        **Mihal Monit**, “Patterns and determinants of material consumption”. Current position: Consultancy in London.
- 2013        **Gonçalo Cardoso**, “Distributed Energy Resources for a Sustainable Built Environment”. Current position: Lawrence Berkeley National Laboratory, USA.
- 2013        **Hana Gerbelova**, “Carbon Capture and Storage Technology Implementation in the Portuguese Energy System”. Current position: JRC's Institute for Energy and Transport, Petten, the Netherlands.
- 2012        **André Pina**, “Advanced modeling of energy systems: the S. Miguel island case study”. Current Position: EDP – Electricity of Portugal.
- 2012        **Leonardo Rosado**, “Material Flow analysis in urban systems: the Lisbon case study”. Current position: Researcher at Chalmers University of Technology, Sweden.
- 2012        **Daniel Weismann**, “Strategies and tools for the urban metabolism characterization”. Current position: Consultant and co-founder of “Co-urbanize” in Boston, USA.
- 2011        **Kiti Suomalainen**, “Integration of renewable energy resources in sustainable energy systems”. Current position: Research Fellow at the University of Auckland

Business School – Energy Center. New Zealand.

Doctoral Program on Leaders for Technical Industries – MIT-Portugal Program

2013 **Eduardo Santos**, “Mapping, Modeling and Improving the WEEE treatment and recovery: a Portuguese case study”. Current position: Managing Partner of 3Drivers.

Doctoral Program in Mechanical Engineering at IST

2010 **Cristiano Alves**, “Ecodesign based on the use of natural fibers based composites”. Current position: Assistant Professor at the Federal University of Rio Grande do Norte, Natal, Brazil.

2010 **Maria João Rodrigues**, “Building integrated photovoltaics (BiPV) technology diffusion into Portuguese urban areas”. Current position: Director of Lisboa enova- Lisbon Energy Agency, Portugal.

2008 **Armando Pinto**, “Buildings Life Cycle Assessment”. Current position: Senior researcher at the National Laboratory on Civil Engineering, Portugal.

2008 **Marta Panão** “Building energy efficiency indicators: influence of urban morphology and microclimatic environment”. Current position: Assistant Professor at the University of Lisbon, Portugal.

2006 **Fausto Freire**, “Life Cycle Assessment and the optimal distribution of natural resources”. Current position: Associate Professor at the University of Coimbra.

2005 **José Amaral** “Development of an Ecodesign methodology for the automobile”. Current Position: Technical Manager of Valorcar, Portugal.

2004 **Jorge Nhambiu**, “Economic Input-Output Life Cycle Assessment: the Portuguese case study”. Current position: Professor at Eduardo Mondlane Univeristy, Former Minister for Science – Government of Mozambique, Mozambique.

2001 **Duarte Pupo Correia**, “Development of tomographic techniques for turbulent flame diagnostics”. Director at the Espírito Santo Bank.

Doctoral Program in Environmental Engineering at IST

2011 **Inês Costa**, “The challenge of industrial symbiosis: a scientific contribution to the development of industrial symbiosis in Portugal”.

2008 **Paulo Ribeiro**, “Waste management in Portugal: modeling the interaction between economic development and waste management infrastructures”.



- 2007 **Aldina Soares**, “The environment as a stimulus for technological innovation: the auto sector”. Current position: Assistant Professor at the Politécnico de Setúbal, Portugal.
- 2007 **Samuel Niza**, “The metabolism of the Portuguese Economy”. Current Position: Manager of Circular.