

## Curriculum Vitae: Ray Gluckman

### Part A - OVERVIEW

#### SUMMARY:

Ray Gluckman is a highly experienced technical and management consultant with over 40 years of experience in the fields of refrigeration, energy efficiency and climate change.

He has been responsible for numerous studies for end users and for policy makers. This has included a wide range of projects related to refrigeration, air-conditioning and heat pumps including technical evaluations, design studies and energy efficiency assessments.

Ray is a leading authority on reducing emissions of the powerful fluorinated greenhouse gases (the "F-Gases", HFCs, PFCs and SF<sub>6</sub>), which are mainly used as refrigerants. He has worked on projects related F-Gases for nearly 30 years and is a technical advisor in this field to the UK Government, the European Commission, the United Nations and the World Bank.

Much of Ray's work has related to improving the energy efficiency of refrigeration and air-conditioning (RAC) systems. He has worked with many end users of RAC equipment to provide advice about efficiency of new and existing equipment. He has also produced guidance documents of RAC efficiency for the UK Government and various industry bodies.

Many recent projects involve the communication of complex technical issues to non-expert audiences. He regularly speaks at conferences and seminars related to reducing emissions of F-Gases and improving energy efficiency of refrigeration and air-conditioning systems. He is a Past-President of the UK Institute of Refrigeration and he won the 2011 UK Cooling Industry Gold Award for his work on F-Gas policy and energy efficiency. He is a member of the Montreal Protocol Refrigeration Technical Options Committee (RTOC) and Technical and Economic Assessment Panel (TEAP) Energy Efficiency Task Force.

#### CURRENT POSITION:

2014 to Current      Managing Director, Gluckman Consulting

#### PREVIOUS EMPLOYERS:

1985 to 2014      Director of Climate Change Division, SKM Enviro

1978 to 1985      Chief Engineer, Refrigeration and Energy Efficiency, W. S. Atkins & Partners

1975 to 1978      Research Officer, Central Electricity Research Laboratories

#### QUALIFICATIONS:

- MA Mechanical Engineering, Cambridge University
- Chartered Engineer, CEng
- Fellow of Institute of Refrigeration, FInstR
- Member of Institution of Mechanical Engineers, MIMechE



## KEY AREAS OF EXPERTISE:

- Refrigeration, Air-conditioning and Heat Pump (RACHP) Systems
- F-Gases and Ozone Depleting Substances
- Energy efficiency
- Climate Change Policy and Compliance
- Carbon Management and Carbon Footprinting
- Development of software modelling tools

**RACHP Systems:** Ray's key speciality area is refrigeration, air-conditioning and heat pumps. He has carried out numerous studies to improve the efficiency of refrigeration systems in a wide range of end use sectors including the chemical industry, food manufacturing, supermarkets and building air-conditioning. He has helped the UK Government and the European Commission develop strategies for the phase out of ozone depleting refrigerants and reducing the emissions of the high GWP HFC refrigerants. He has also carried out a range of refrigeration design studies and has worked as an expert witness in relation to disputes on refrigeration and air-conditioning equipment.

**F-Gases and Ozone Depleting Substances:** Ray is a well-known international expert in the field of F-Gases and ODS. He has supervised a number of major projects for the European Commission, the UK Government and various industrial clients to assess emissions of these powerful global warming gases and to investigate ways in which such emissions can be reduced. He has extensive experience of the EU F-Gas and Ozone Regulations and the Montreal Protocol and its Kigali Amendment.

**Energy efficiency:** Much of Ray's consultancy work over the last 40 years has related to energy efficiency and energy use strategy. This has included numerous energy audits and feasibility studies for industrial and commercial energy users. He has had experience of energy efficiency projects in most industrial sectors, including food and drinks, chemicals and pharmaceuticals, iron and steel, cement, paper, textiles and general engineering. He has also carried out energy efficiency work related to large and small buildings. Strategy work has included projects for Government, institutional and private clients. Ray has been responsible for energy management studies that have included all stages of investigation, including initial auditing, identification of specific energy saving opportunities, detailed feasibility studies, engineering design and project implementation.

**Climate Change Policy and Compliance:** Ray has carried out a wide variety of climate change policy and compliance projects for Government departments, Trade Associations and individual companies. For example: he has provided advice to the UK Government and to numerous major companies about the development and implementation of a number of climate change policies. As well as F-Gas and ODS policies this has included work on emissions trading (UK and EU Emissions Trading Schemes), UK Climate Change Agreements and the UK Carbon Reduction Commitment.

**Carbon Management and Carbon Footprinting:** Ray has been involved in numerous carbon management and carbon footprinting projects. In 2002 he helped the UK's Carbon Trust develop their initial ideas about Carbon Management and providing support to help companies measure their CO<sub>2</sub> footprint and to reduce emissions.

**Software Tools:** Ray has developed a number of software tools to support various projects. This has included expert systems for refrigeration system fault diagnosis, databases for Energy Monitoring and Targeting and a number of sophisticated spreadsheet tools such as modelling of the use and emissions of refrigerants and other F-Gases. He has helped develop the *HFC Outlook* modelling tool to assess national and regional consumption of HFCs to support policy development under the Kigali Amendment.

## Part B: Experience related to F-Gas and ODS Policy

Ray Gluckman has extensive experience related to the use and emissions of F-Gases (fluorinated greenhouse gases, HFCs, PFCs and SF<sub>6</sub>) and ODS (ozone depleting substances, CFCs and HCFCs). He is an expert on policies and regulations being used to reduce use and emissions of these gases such as the Montreal Protocol, the EU F-Gas and ODS Regulations and the Kigali Amendment to the Montreal Protocol.

Ray has worked in the F-Gas and ODS policy field nearly 30 years. In 1991 he conducted the UK Government's first investigation into ODS alternatives in the refrigeration and air-conditioning sectors and in 1995 he developed the UK's first F-Gas Emissions inventory. Since that time he has been closely involved with the development of ODS and F-Gas policy, providing technical support to Government bodies (in particular for the European Commission, the UK Government and the United Nations Ozone Secretariat) and to various private sector clients. Important examples of Ray's experience include:

- a) **Technical Secretary to the F-Gas Working Group of the European Climate Change Programme (ECCP), 2000 – 2001.** Ray worked for the European Commission as the technical secretary to this group, providing techno-economic evaluations of F-Gas alternatives in each F-Gas application sector. The key output of the ECCP F-Gas Working Group was a recommendation for the development of an EU F-Gas Regulation.
- b) **Technical support to UK Government (Defra) and European Commission during development of 842/2006, 2003 - 2006.** Ray carried out a number of projects to evaluate various aspects of the new EU F-Gas Regulation as it underwent a long development process.
- c) **UK Implementation of EU 2006 F-Gas Regulation via “F-Gas Support”, 2007 to 2012.** F-Gas Support was a major programme managed for Defra by Ray Gluckman over a 5-year period. The UK Government recognised that the wide range of end user sectors would need significant support to implement the F-Gas Regulation. F-Gas Support provided a range of support measures including comprehensive sector guidance, a telephone help line and numerous presentations about the F-Gas Regulation to stakeholder groups.
- d) **Technical support to European Commission DG Clima, 2012/2013.** Ray managed a programme of technical support to the F-Gas team at DG Clima during the crucial negotiation phase of the second EU F-Gas Regulation 517/2014. Ray also provided technical input to the EU Parliament and to the Irish and Lithuanian EU Presidencies.
- e) **Technical and policy support to UK Government, 2014 to 2020.** Ray provides on-going support to Defra in relation to the EU F-Gas Regulation and the Montreal Protocol.
- f) **Technical support to the United Nations Ozone Secretariat and UN OzonAction, 2015 to 2020.** Ray has provided support to the UN during the negotiation of the Kigali Amendment to the Montreal Protocol which was agreed in October 2016. This included preparation of a set of detailed Fact Sheets about low GWP alternatives to HFCs and a set of Fact Sheets about how the Kigali Amendment will be implemented.
- g) **Modelling of use of HFCs and lower GWP alternatives, 2012 to 2020.** Ray has carried out extensive modelling of HFC use in key markets including refrigeration, air-conditioning, foams, aerosols, fire protection and solvents. He has developed a detailed model, *HFC Outlook*, which has been used to assess HFC phase-down in the EU and in 10 Article 5 countries. During 2020 the *HFC Outlook* model is being extended to assess both gas consumption (and the related “direct greenhouse gas emissions) and energy consumption (and the related “indirect GHG emissions).

## Part C: Track Record related to F-Gas and ODS Policy

The list below are examples of projects carried out and/or managed by Ray Gluckman

Year	Client	Project Description
2016 to 2020	UN Ozon Action	Development of <i>HFC Outlook</i> modelling tool for use by Article 5 (developing) countries to assess current and future use and emissions of HFCs. 10 country models completed (for Bahrain, Bosnia, Dominican Republic, Gabon, Guatemala, Honduras, Kuwait, Mali, Senegal, Sri Lanka)
2019 to 2020	UN Environment Programme	Extension of <i>HFC Outlook</i> modelling capabilities to include energy related greenhouse gas emissions.
2019 to 2020	UK Government (Defra)	Technical and strategic support to the Defra F-Gas and Ozone team in relation to Montreal Protocol and EU Regulation issues.
2010 to 2020	UK Government	Preparation of the annual F-Gas Emissions inventory for the UK Government, including report preparation to meet EU and UN FCCC reporting requirements.
2015 to 2018	UN Ozone Secretariat	Support to the Ozone Secretariat related to proposals to introduce a global HFC phase-down. This work included <ul style="list-style-type: none"> <li>• preparation of 15 Fact Sheets that summarise the low GWP alternatives to HFCs in the wide range of end user markets</li> <li>• preparation of technical briefing material about the safety issues related to the use of flammable refrigerants</li> <li>• organisation of a workshop on the interactions between energy efficiency and HFC phase-down under the Kigali Amendment.</li> </ul>
2017	UN OzonAction	Preparation of a set of 19 Fact Sheets about the Kigali Amendment to the Montreal Protocol.

2016	World Bank	Support to the Montreal Protocol team in the World Bank to prepare guidance material for World Bank investment managers related to the benefits of using low GWP alternatives to HFCs.
2015 to 2019	European Partnership for Energy and Environment (EPEE)	Development of a “roadmap” to assess how the challenging HFC phase-down targets in the EU F-Gas Regulation can be met. Market research with key sectors of the EU refrigeration and air-conditioning industry to measure progress towards meeting the phase-down targets.
2015	UK Government (Defra)	Preparation of Information Sheets on the 2014 EU F-Gas Regulation to support implementation and compliance. A set of 30 Information Sheets were prepared including 13 targeted at the wide variety of end user sectors, together with further Information Sheets addressing (a) contractors, manufacturers and importers, (b) training and certification and (c) other aspects of the Regulation (such as an explanation of the CO <sub>2</sub> thresholds used in the Regulation).
2015 to 2016	European Commission, DG Clima	Assessment of the impact of the EU F-Gas Regulation on the price of refrigerants.
2015	European Commission, DG Clima	Assessment of barriers to use of low GWP alternatives to HFCs related to international safety codes, national and regional safety legislation and training.
2014	UK Government (Defra)	Impact Assessment of new F-Gas Regulation (517/2014) prior to public consultation on draft UK Implementing Legislation
2012 to 2013	European Commission, DG Clima	Technical support related to the new F-Gas Regulation and international discussions on HFCs. The work programme for this project provided crucial insights to the negotiations between the Council and European Parliament.
2013 to 2014	UK Government (Defra)	Technical support related to negotiation of new F-Gas Regulation, including detailed modelling of HFC phase down and a detailed review of phase down proposals from North America and the EC.

2012	European Partnership for Energy and Environment (EPEE)	Detailed study of HFC phase down in the EU refrigeration, air-conditioning and heat pump sectors. This project included development of a sophisticated computer model to provide estimates of future EU consumption of HFCs.
2012 to 2014	UK Government (DECC)	Specialist work on F-Gas emissions to support Ricardo-AEA on the National Greenhouse Gas Inventory. Recent work has included a review of emissions from medical aerosols, a detailed SF <sub>6</sub> inventory and an assessment of UK use and emissions of NF <sub>3</sub> .
2008 to 2012	UK Government (Defra)	Ray Gluckman managed "F-Gas Support", a major programme for the UK Government to help ensure compliance with both F-Gas and Ozone Regulations. We produced a wide range of guidance material covering the F-Gas Regulation, the MAC Directive, the Ozone Regulation and all supporting Commission Regulations. This work also included regular contact with users of F Gases to establish inventories and leak rates and to track compliance.
2012	Australian Government (DSEWPaC)	Assessment of F-Gas markets to support introduction of F-Gas carbon tax on imports of bulk supplies and pre-charged equipment and products
2011	European Commission, DG Clima	Assessment of Ozone and F Gas Banks in the EU – a study of end-of-life emissions from banks of F-Gases and ODS from end uses such as insulating foam, refrigeration and air-conditioning and gas insulated switchgear.
2012	Scotland and Northern Ireland Governments	Review of compliance with EU F-Gas Regulations, including checks on whether RAC contractors hold a Company Certificate.
2011	Defra	Assessment of GHG emissions from refrigeration systems in the food chain. A study to identify "GHG emission hot spots" and to recommend actions to reduce emissions from refrigeration systems in various parts of the food chain.
2010	European Partnership for Energy and Environment (EPEE)	Eco-Efficiency Study on Supermarket Refrigeration – environmental and economic assessment of different types of refrigeration systems for a standard European supermarket, using the eco-efficiency methodology.

2009	Irish Environment Protection Agency	F-Gas Regulation Enforcement Support –technical support to the Irish EPA in their role as the regulatory body for the F-Gas Regulations.
2008	Irish Government	Review of implementation and enforcement of the F Gas Regulation in Ireland on behalf of Irish Government.
2008	UK Food and Drink Federation	Preparation of guidance notes on the F Gas and Ozone Regulations for the food and drink industry.
2007	UK Government (Defra)	Major review of implementation and enforcement of the F Gas Regulation on behalf of UK Government.
2007	Defra	Economic impact assessment of F Gas Regulations prior to introduction of UK implementing legislation.
2003	UK Government (Defra)	Assessment of the possible environmental, economic and social impacts of the EC proposal on reducing emissions of HFCs, PFCs and SF <sub>6</sub> .
2002	European Commission	Assessment of Regulations for Reducing Emissions of F-Gases.
2001	UN FCCC	Methods used to estimate inventories of HFC, PFC and SF <sub>6</sub> emissions.
2000/1	EC: ECCP F Gas Working Group	Technical Secretary to ECCP F Gas Working Group. These important meetings formulated the basis for the 2006 EU F Gas Regulation. The support provided included preparation of technical briefing notes and introductory presentations at Working Group meetings.
2000	International Pharmaceutical Aerosol Consortium	Review of HFC Emissions from medical aerosols (MDIs) and alternative technologies such as dry powder inhalers (DPIs).
2000	UK Government (Defra)	Economic impact assessment of new EU Ozone Regulations.

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1999	European Commission and Dutch Government Organisation of a major international conference on F Gases, Netherlands.
1999	UK Government (Defra) UK F Gas Inventory and assessment of emission reduction opportunities
1998	European Commission (DG Industry) Preparation of the first EU HFC emissions inventory
1997	UK Government (Defra) UK HCFC emissions inventory and assessment of alternative technologies
1996	UK Government (Defra) Preparation of the first UK F-Gas emissions inventory
1991	UK Government (Defra) Preparation of the first evaluation of the impact of CFC and HCFC phase-out on the UK refrigeration and air-conditioning sectors.

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## Part D: Publications

F-Gas Regulation Update, RAC Magazine Question Time, 2020

What happens to HFC refrigerants at the end-of-life, EPEE Industry Roundtable, 2020

Modelling the EU HFC Phase-down, JARN (Japan Air Conditioning, Heating & Refrigeration News), 2019

The Changing EU Refrigerants Market in relation to the EU F Gas Regulation and the Kigali Amendment, Honeywell Seminar, 2019

Assessment of the potential to reduce UK F-gas emissions beyond the ambition of the F-gas Regulation and Kigali Amendment, report prepared for UK Committee on Climate Change, 2019

Selecting refrigerants during the global phase-down of HFCs, 1st IIR International Conference on the Application of HFO Refrigerants, UK, 2018

The opportunity for rapid transition to energy efficient low-GWP alternatives for building air conditioning chillers, 1st IIR International Conference on the Application of HFO Refrigerants, UK, 2018

Cooling Efficiency: technologies, UN Workshop on energy efficiency opportunities while phasing-down HFCs, Vienna, 2018

3 Briefing Notes on Refrigeration and Air-conditioning Energy Efficiency, UN Workshop on energy efficiency opportunities while phasing-down HFCs, Vienna, 2018

Technology Selection and Trends, First Inter-Regional Thematic Workshop for National Ozone Officers, Paris, 2018

Achieving the Phase-Down in Europe: Roadmap and Reality, Update on the EPEE Gapometer, OEWG 2017

19 Fact Sheets on the Kigali Amendment, prepared for UN OzonAction, 2017

Preparing for HFC phase-down: bans, quota reductions, global phase-down and Brexit, RAC Magazine Question Time, 2017

3 Briefing Notes on Refrigeration Safety Issues, UN Workshop on safety standards relevant to the safe use of low-global-warming-potential alternatives, Bangkok, 2017

Meeting the ambitions of the F-Gas Regulation, Chillventa Symposium, 2016

Maximizing climate mitigation benefits through refrigeration and air-conditioning investments, Guidance prepared for World Bank, 2016

15 Fact Sheets on HFCs and low GWP alternatives, for UN Ozone Secretariat, 2015 (updated 2017)

Information Sheets on the EU F-Gas Regulation, prepared for UK Government, 2015

Use of refrigeration in UK soft drinks supply chain, report prepared for UK Government, 2014

Examination of the global warming potential of refrigeration in the food chain, report prepared for UK Government, 2012

Further assessment of policy options for the management and destruction of banks of ODS and F-Gases in the EU, report prepared for European Commission, 2012

Reducing Greenhouse Gas Emissions from Refrigeration and Air-Conditioning Systems, Carbon Trust Seminar, 2011

Cold Store Energy Efficiency, Food Storage and Distribution Federation Conference, 2011

Environmental Impacts of the Food Service Sector, report prepared for UK Government, 2010

Review of HFC Phase Down Scenarios, report prepared for UK Government, 2010

Eco-efficiency study of supermarket refrigeration, report prepared for the European Partnership for Energy and the Environment (EPEE), 2010

UK climate change policies - the success of voluntary agreements with energy intensive industries, Energy Efficiency Seminar, Prague, 2009

F Gas and Ozone Regulation Requirements and impact on efficiency of buildings, CIBSE / IOR Conference, 2008

Information Sheets on EU F-Gas Regulation 2006, prepared for UK Government, 2008

Promoting compliance with F Gas and Ozone Regulations, Food & Drink Federation Conference, 2008

Future Refrigeration Challenges, SEI Workshop, Ireland, 2006

Energy benchmarking assessment of UK food canning industry, report prepared for Carbon Trust, 2005

Phase-out of R22: timescale and alternatives, RAC Magazine Conference, 2003

Background to climate change initiatives in the UK, Seminar with New Zealand Government, 2003

Practical experiences of climate change levy agreements, Institute of Energy Conference, 2003

Carbon Manual – a reference guide to carbon management, report prepared for the Carbon Trust, 2002

Final report on the European Climate Change Programme Working Group Industry, work item Fluorinated Gases, report prepared for the European Commission, 2001

UK emissions of HFCs, PFCs and SF<sub>6</sub> and potential emission reduction options, report prepared for UK Government, 1999

Future Refrigeration Challenges: HCFCs and their Alternatives in the European Union, report prepared for European Commission DG III, 1997

Refrigeration and Global Warming, report prepared for EFCTC (European Fluorocarbon Technical Committee), 1997

Refrigeration Efficiency Investment, a Good Practice Guide published by UK Government, 1997

Presenting the economic case for efficiency improvement, IOR/IMechE Conference, London 1997

Cost effective refrigeration and the challenge of CFC/HCFC replacement, IChemE NW Branch Symposium, Warrington, 1997

UK use and emissions of halocarbons, RUG Conference, London 1997

Cutting the cost of refrigerant leakage, a Good Practice Guide published by UK Government, 1997

UK Use and Emissions of Selected Halocarbons, report prepared for UK Government, 1996

Avoiding problems caused by hydraulic shock in refrigeration systems, IOR/IMechE Conference, 1996

Energy efficient design and operation of refrigeration compressors, a Good Practice Guide published by published by UK Government, 1995

The Impact of Refrigeration on the Global Environment, Presidential Address to IOR, Proc. IOR, 1994/5

Industrial refrigeration plant – energy efficiency design, a Good Practice Guide published by published by UK Government, 1993

Optimisation of refrigeration plants for off-design operating conditions, Proc. IOR, 1992/3

Using expert systems for improving the design and operation of refrigeration plants, International Institute of Ammonia Refrigeration Conference, Miami, USA, 1992

The development of refrigeration expert systems, Proc. IOR, 1991/2

CFCs in the UK refrigeration and air-conditioning industries, report prepared for UK Government, 1992

Energy saving in refrigeration, Energy Efficiency Symposium, Hong Kong Institution of Engineers, Hong Kong, 1991

Energy efficiency in domestic electric appliances, report prepared for UK Government, 1990

Industrial heat pump manual, report prepared for EPRI (Electrical Power Research Institute), 1988

Industrial heat pumps and process integration, Steam Compression Conference, Aberdeen, 1988

Experience in heat recovery, IMechE Conference, Energy in the Process Industries, London 1985

Heat pumps – a realistic approach, National Energy Management Conference, Birmingham 1983

Heat pump cycles and their engineering, Heat Pumps for Buildings International Conference, Nottingham, 1983

Heat pumps in industry, Seminar, Portman Hotel London 1982

Heat recovery from cooling systems, CIBSE Conference, Bristol 1981

Case studies showing the potential for energy saving in industrial heat pump systems, ESC Energy Conference, London, 1981

The effective use of process data, Institute of Measurement and Control Conference, 1981

The potential for energy saving in refrigeration, Refrigeration and Air-conditioning Journal, 1981

Economic evaluation of heat pumps, CIBS Heat Pump Conference, Bath University, 1981