

**INSTITUT INTERNATIONAL
DU FROID**

Organisation intergouvernementale
pour le développement du froid



**INTERNATIONAL INSTITUTE
OF REFRIGERATION**

Intergovernmental organization
for the development of refrigeration

177, boulevard Malesherbes, F-75017 PARIS, France

Tél. 33-(0)1 42 27 32 35 – Fax 33-(0)1 47 63 17 98 – E-mail: iifiir@iifiir.org – Web: www.iifiir.org

IIR Working Party *on Life Cycle Climate* *Performance Evaluation*

Yunho Hwang, Ph.D.

Chair of LCCP WP

Vice President of Commission B1

IIR Working Party: Life Cycle Climate Performance Evaluation

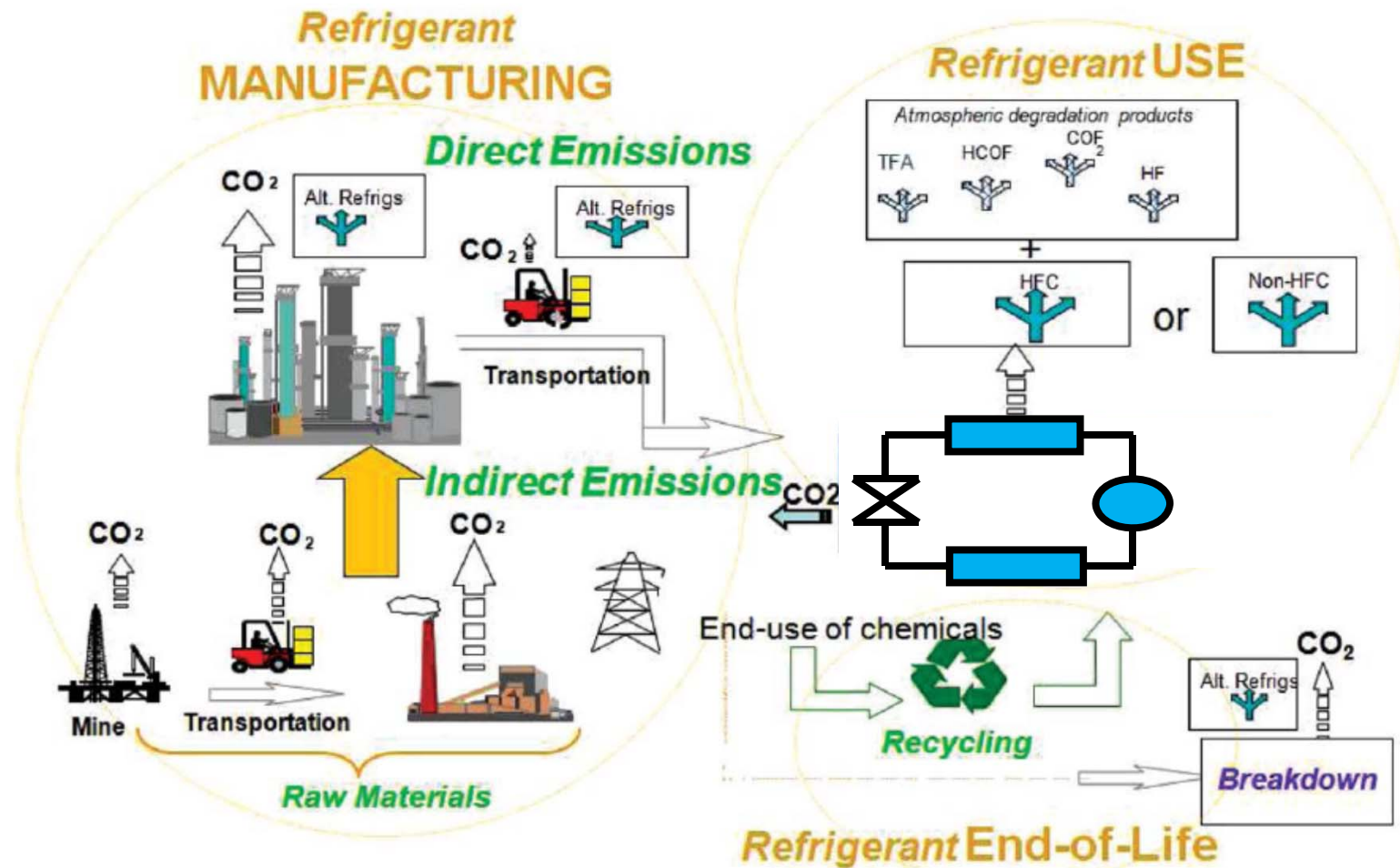
Agenda

Time	Topic	Organizer/Presenter
8:30am - 9:00am	Registration	
9:00am - 9:30am	LCCP WP Overview and Update	Yunho Hwang
9:30am - 10:30am	Overview of Recent LCCP Model Efforts	Vikrant Aute, U. of MD
10:30am - 10:45am	Overview of AHRI & PacCal LCCP Models	Yunho Hwang (on behalf of Ming Zhang & Morten Juel Skovrup)
10:45am – 11:00pm	Discussion 1 - Membership	Yunho Hwang
11:00am – 12:00pm	Discussion 2 - Emission factors	Yunho Hwang
12:00pm – 1:00pm	Lunch	
1:00pm – 2:00pm	Discussion 2 - Continued	Yunho Hwang
2:00pm – 3:00pm	Discussion 3 - Task Assignment Discussion 4 - Meeting Schedule	Yunho Hwang
3 pm	Adjourn	Yunho Hwang

- Meeting location: Lecture Room C (LR-C) located in the Administrative Building (aka Bldg 101) at NIST



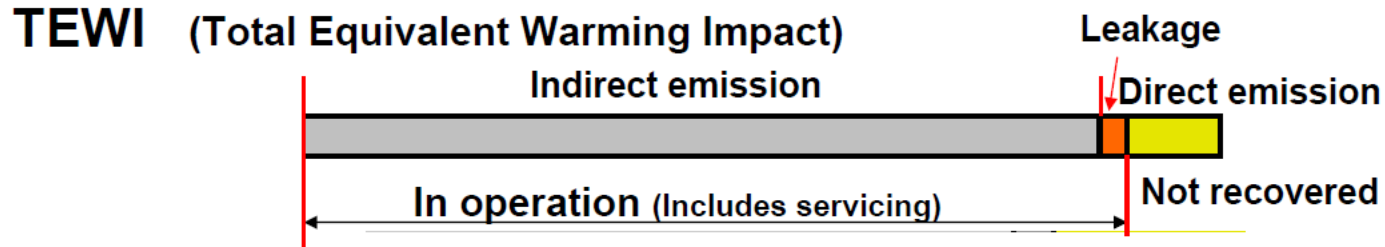
Environmental Impacts of Refrigerants



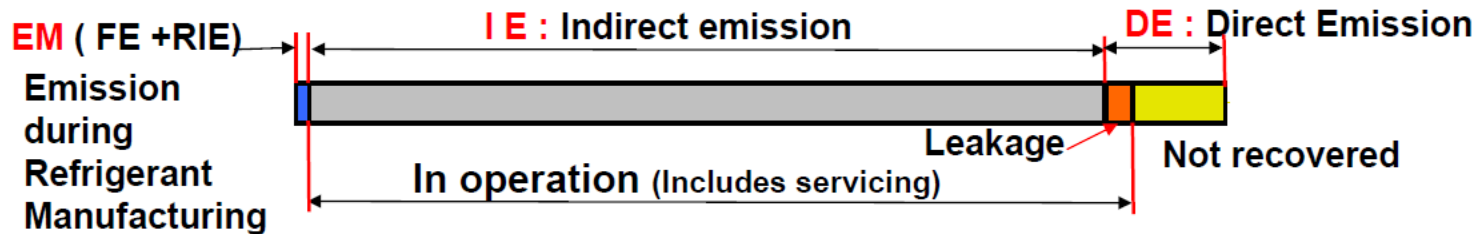
- Source: The Life-Cycle-Climate Performance Metric for Mobile Air Conditioning Technology Choice, Stella Papasavva and Stephen O. Andersen, Environmental Progress and Sustainable Energy Journal, Vol. 30, 2010.



Some Metrics



LCCP (Life Cycle Climate Performance) **“Simple comparison for refrigerant”**



LCA (Life Cycle Assessment- LCCO₂)



• Source: LCCP OF SOME HVAC & R APPLICATIONS In Japan, Haruo Onishi, Ryuzaburo Yajima, Shotaro Ito, April, 2004 Earth Technologies Forum.



Some Metrics

- **TEWI (Total Equivalent Warming Impact):**

$$\text{TEWI} = \text{GWP (direct)} + \text{GWP (indirect)}$$

- Due to refrigerant leaks
- Due to A/C operation

- **LCCP (Life Cycle Climate Performance):**

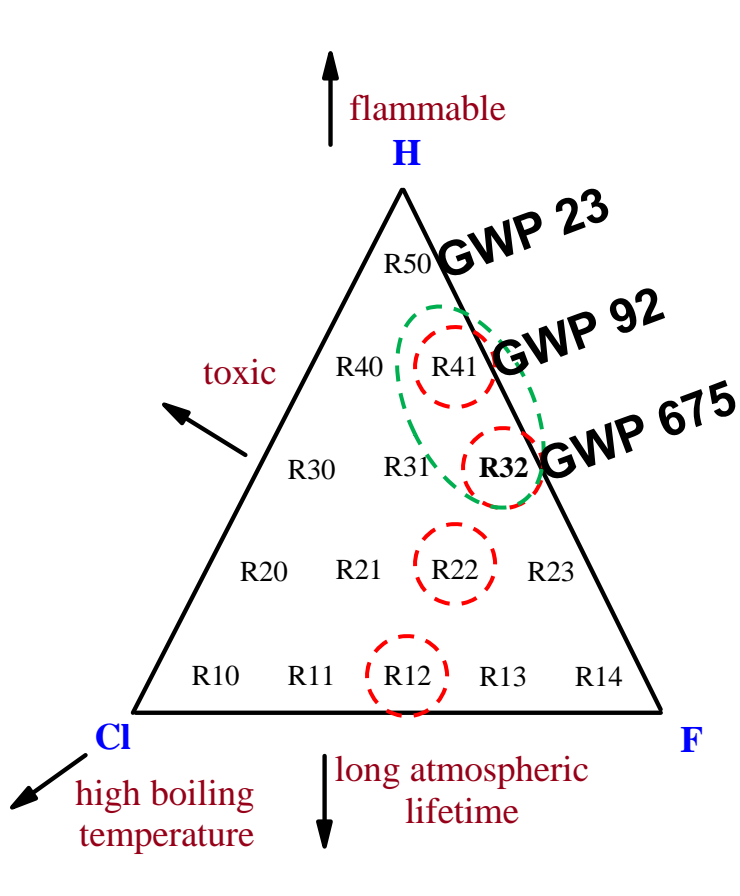
$$\text{LCCP} = \text{TEWI}$$

- + **GWP (Indirect)** [energy consumption expressed as CO₂-eq emissions from chemical production & transport, manufacturing components & product assembly and end-of-life]
- + **GWP (direct)** [chemical refrigerant emissions including atmospheric reaction products, manufacturing leakage, and end-of-life]

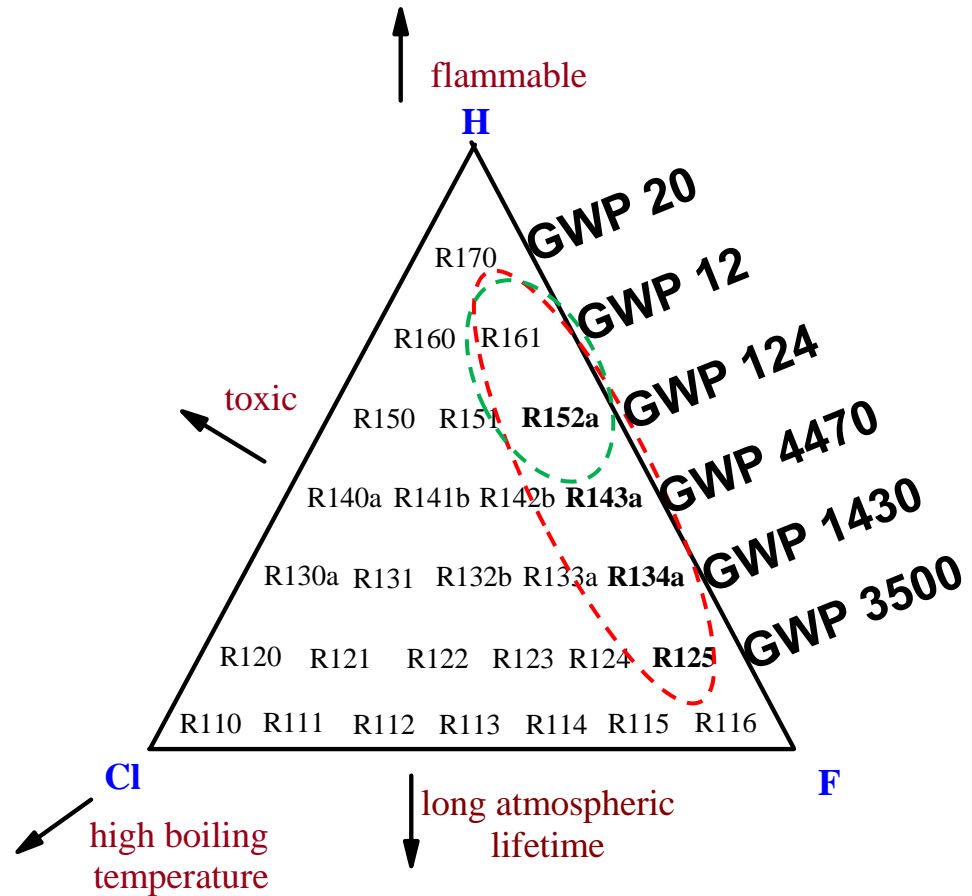
- Source: Green-MAC-LCCP, Stella Papasavva and Stephen O. Andersen, 2008



Properties of Carbon Based Refrigerants



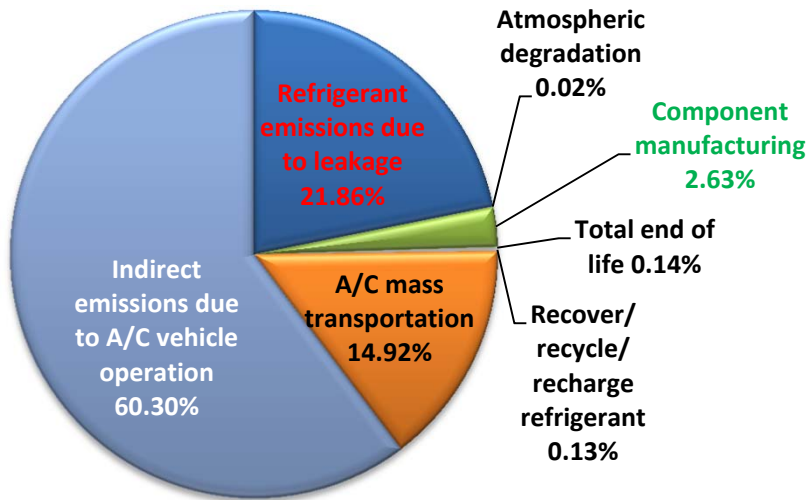
(a) Methane series



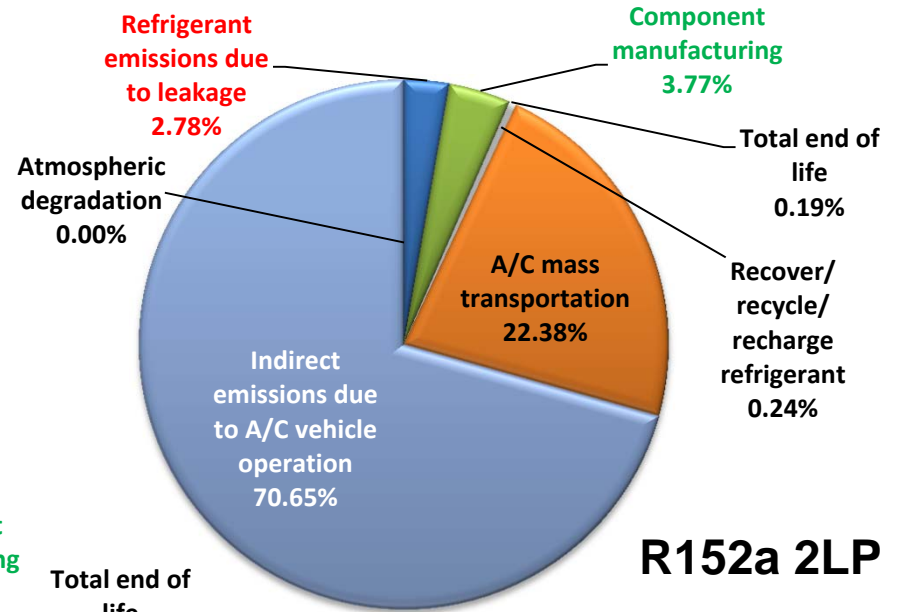
(b) Ethane series



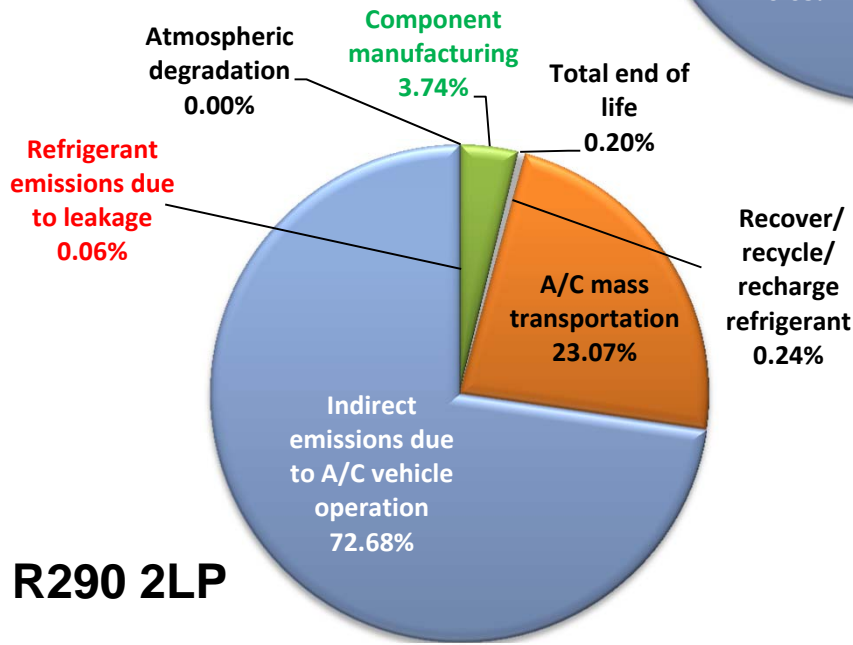
LCCP Contributions: MAC



R134a Baseline



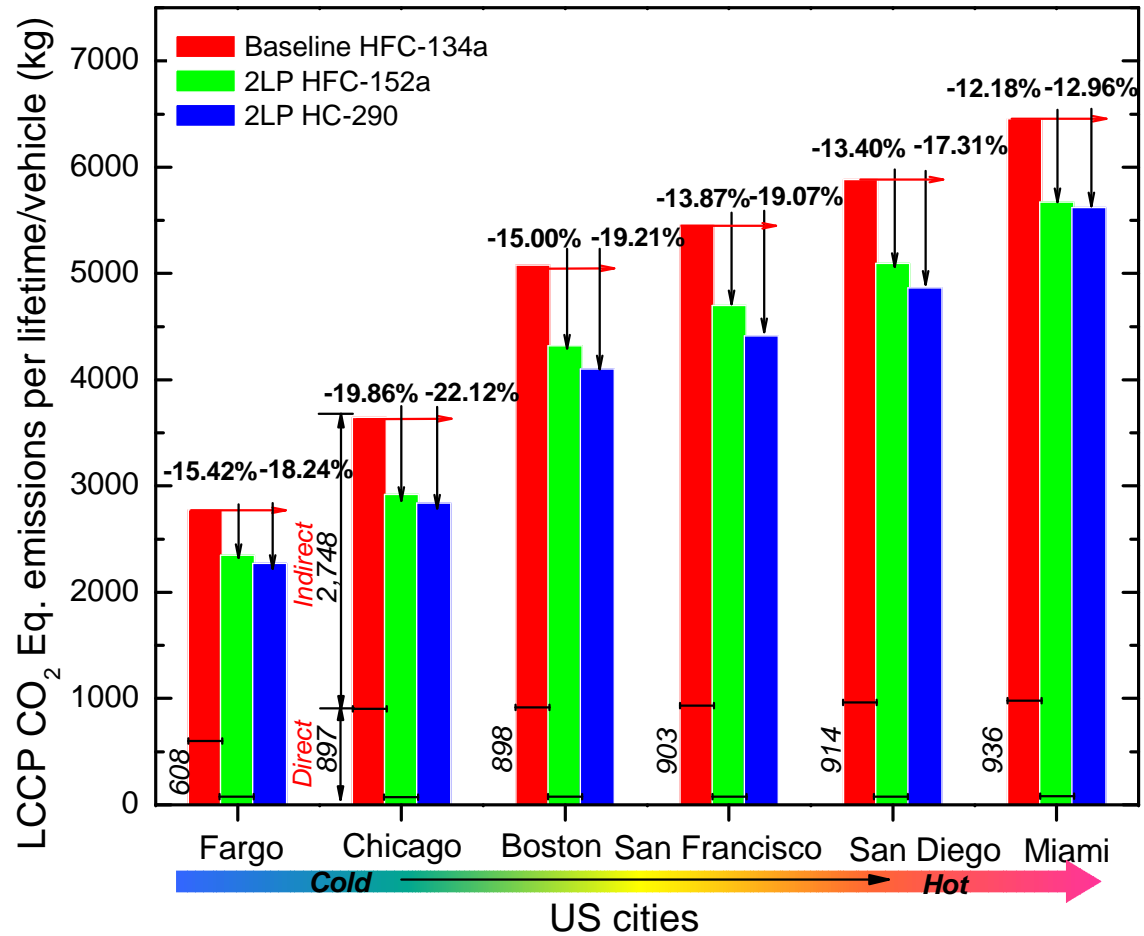
R152a 2LP



R290 2LP



LCCP Comparison: MAC, US Cities



Tools Available

- GREEN MAC LCCP (2004) – Excel based



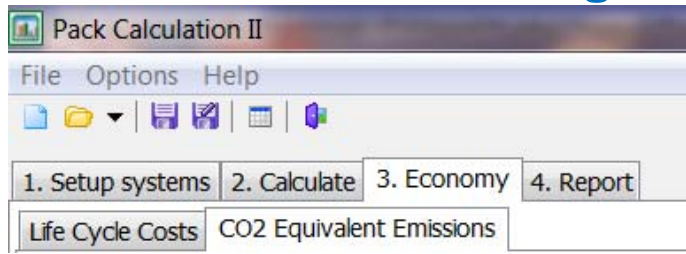
- AHRTI's Residential HP LCCP (2011) – Excel based

	Instructions	Energy_Cal	Refrigerants	Perf_Data_Input	HP_Manu_Simpl	HP_Manu_Detail
	EOL (simple)	EOL(detailed)	Leakage	Power_Gen_CO2	Climate Data	Run Model
Data Set / Runs	1	2	3	4	5	
Refrigerant	R-134a	R-410A	R-410A	R-410A	R-410A	R-410A
Location	St Louis	Washington, DC	Seattle			
Heating Region	III					
Power Generation Division	Pacific Noncontiguous					
System_Type	Single stage	Single stage	Two stage			
System_Matl	HP_Equip_Simple	HP_Equip_Deailed	HP_Equip_Simple			
EOL	EOL(simple)	EOL(detailed)				

- ORNL's Supermarket Refrigeration LCCP (2012) –Web based



- IPU's Pack Calculation II, Refrigeration Plant TEWI (2012)



Needs for New LCCP

- How to improve accuracy?
- How to quantify the importance of each contribution?
- **How to harmonize the LCCP methodology?**
- Do we need different versions?
 - Research version for accuracy
 - Public version for easy use



IIR's LCCP Working Party (WP)

- In response to global warming concerns, the IIR has been advocating environmentally friendly, safe, energy-efficient and cost-effective design, operation and end-of-life management of refrigeration and air-conditioning systems.
- As part of these efforts, the IIR formed a working party to assess the merits of different methods for evaluating the environmental impact of refrigerants and to produce implementation protocols for these methods.



LCCP WP: Approach

- **Collect information on direct and indirect emissions of working fluids for various applications from individual countries and from the current IIR's WP on Mitigation of Direct Emissions of GHGs**
- **Initiate within IIR member states the formation of similar Working Party-Groups to cooperate with the IIR Working Party**
- **Establish the LCCP evaluation methodology applicable for refrigeration and air conditioning systems**
- **Evaluate how different assumptions selected by a user of these methodologies can affect the result of the assessment.**



LCCP WP: Approach

- Evaluate how improvement options can affect the result of the assessment.
- Assemble such information and to disseminate it amongst WP members and all IIR member states
- Write a booklet on the LCCP evaluation methodology developed and make it available to members of the WP and all IIR members, and to non-members via Fridoc
- Support and promote international collaboration and initiatives to improve the LCCP of the refrigeration and air conditioning systems
- Represent the IIR at events dealing with environmental impact evaluation



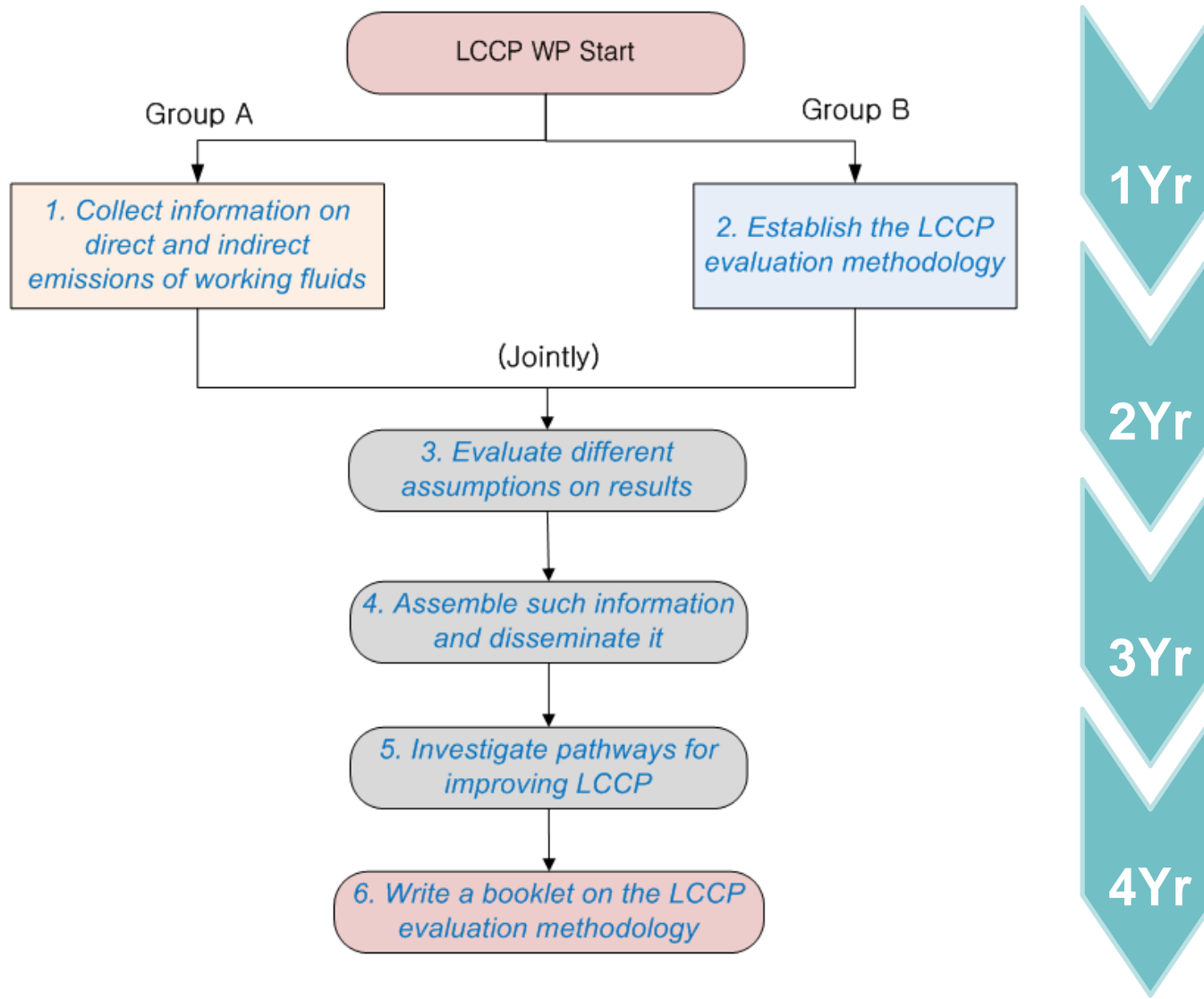
LCCP WP: Timescale

- WP started: **January 2012**
- Entire WP efforts: **4 years**
- First WP meeting: **Delft, June 2012**, during the 10th IIR-Gustav Lorentzen Conference on Natural Working Fluids (GL2012)
- WP shall hold one or two meetings per year.
- Minutes shall be taken at each meeting and posted on the IIR web page of the Working Party.

Phase	Prep. phase	Working phase		
Year	2012	2013	2014	2015
Meeting	2	2	2	2



LCCP WP: Roadmap



LCCP WP: Deliverables

- **Consolidated listings and references for relevant information on direct and indirect refrigerant emissions**
- **One statement, position paper and/or Informatory Note**
- **Booklet on the LCCP evaluation methodology**
- **A workshop with the publication of the proceedings in CD-ROM form**
- **Periodically updated web page on the IIR site**



LCCP WP: Website

- A new web site of the working party is prepared.
- Basic information of the working party can be obtained from this web site.

http://www.iifiir.org/medias/medias.aspx?INSTANCE=EXPLOITATION&PORTAL_ID=portal_model_instance_WP_LCCP_Evaluation.xml

Working Party on LCCP Evaluation



Welcome to the Working party Web page

Since the main part of the global warming contribution from refrigeration equipment (including air conditioning) is due to indirect emissions, the climate performance of refrigerating system during its life cycle is an area of concern. Moreover, its proper evaluation is a key factor in determining the true impacts of working fluids for specific application and geographic location, and will assist in determining next generation working fluids for refrigeration and air-conditioning systems.

The IIR has therefore decided to set up a working party (WP) to assess the merits of different methods for evaluating the **Life Cycle Climate Performance (LCCP)** for refrigerating systems environmental impact of refrigerants and to produce implementation protocols for these methods, for use by decision makers and refrigeration stakeholders. **Yunho Hwang**, Vice-President of IIR Commission B1, is the chairman of this new WP, which started from January 2012, after approbation of the Science and Technology Council of the IIR.



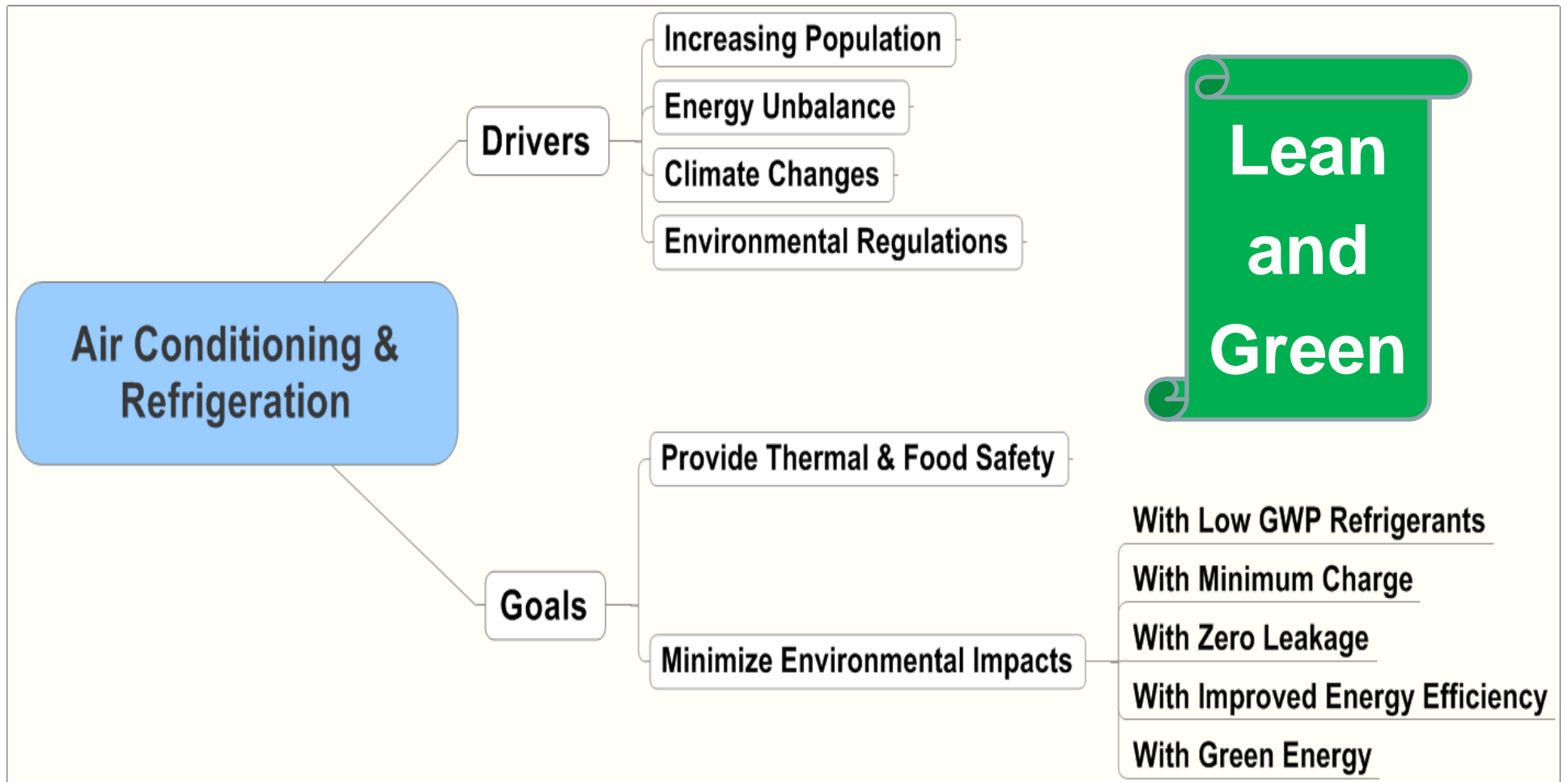
LCCP WP: Membership

- **Membership of the Working Party should be multi-national and open to private members or representatives of corporate members of the IIR.**
- **The IIR is currently recruiting members from following areas for this WP:**
 - **Commission, private, and corporate members of the IIR**
 - **Experts whose knowledge of the subject will benefit the WP**

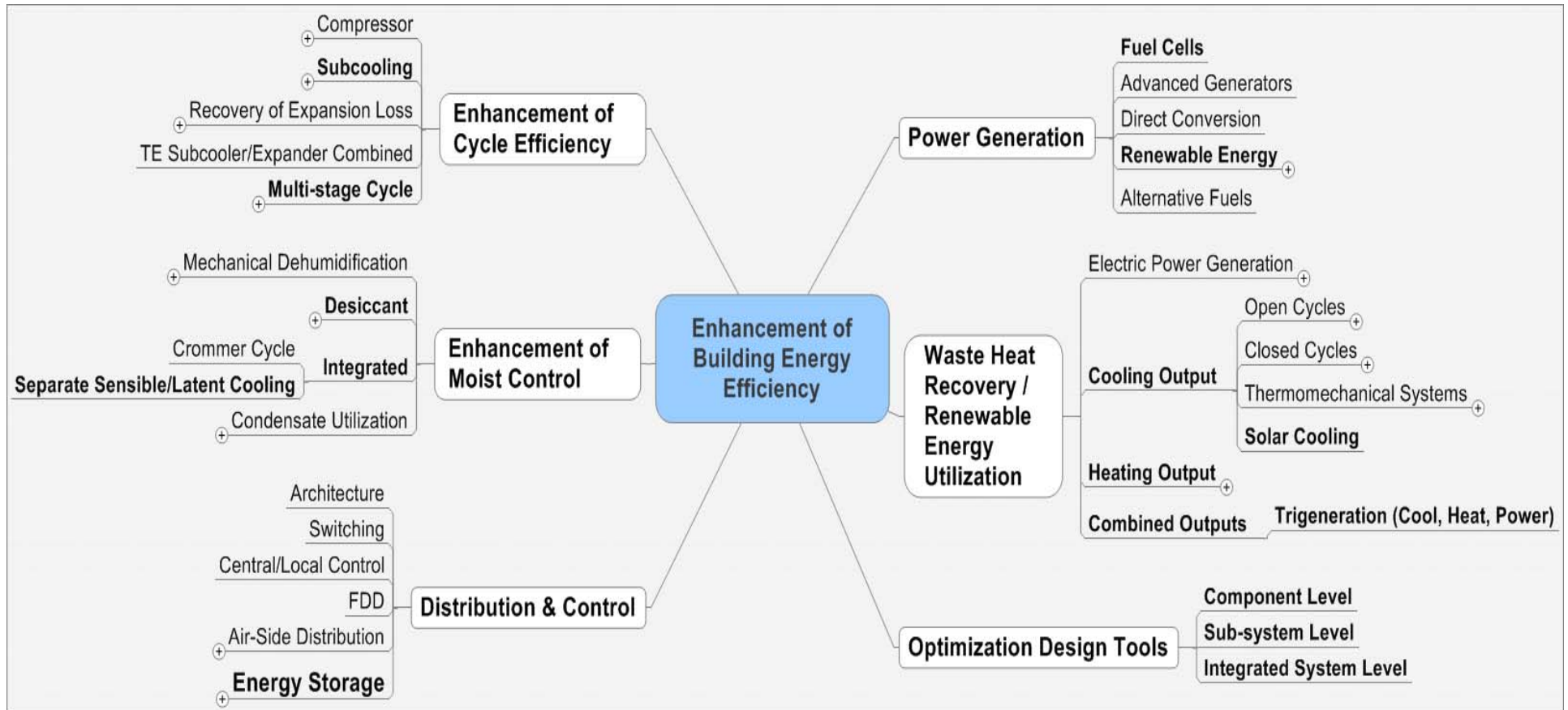
**You are
invited!**



Our Goals

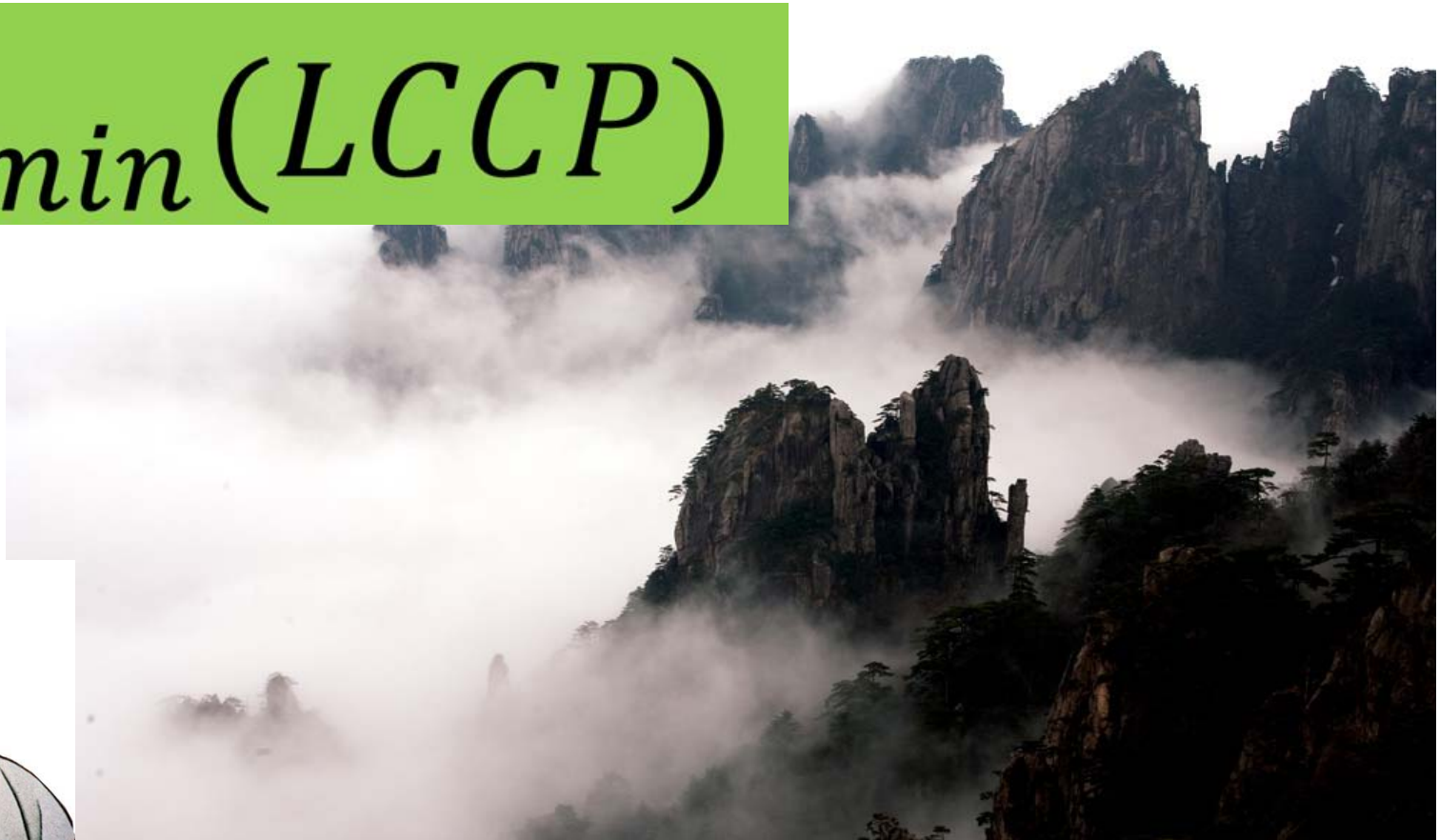


Pathways for Efficiency Enhancement



*Life comes from the earth and
Life returns to the earth!* Zhuangzi

• $f_{min}(LCCP)$



Zhuangzi was an influential Chinese philosopher who lived around the 4th century BC.