INSTITUT INTERNATIONAL DU FROID
Organisation intergouvernementale pour le développement du froid

INTERNATIONAL INSTITUTE OF REFRIGERATION
Intergovernmental organization for the development of refrigeration

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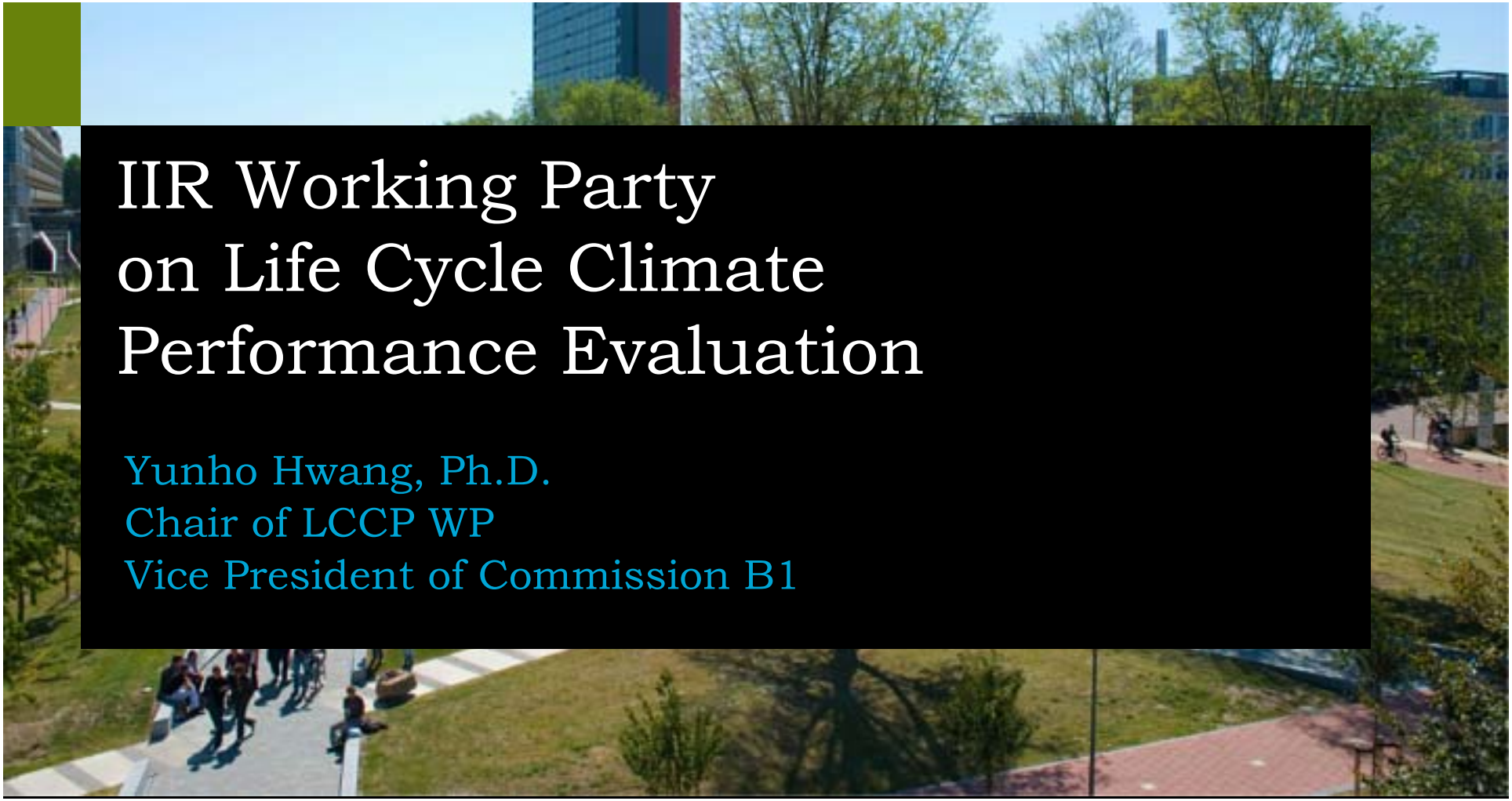


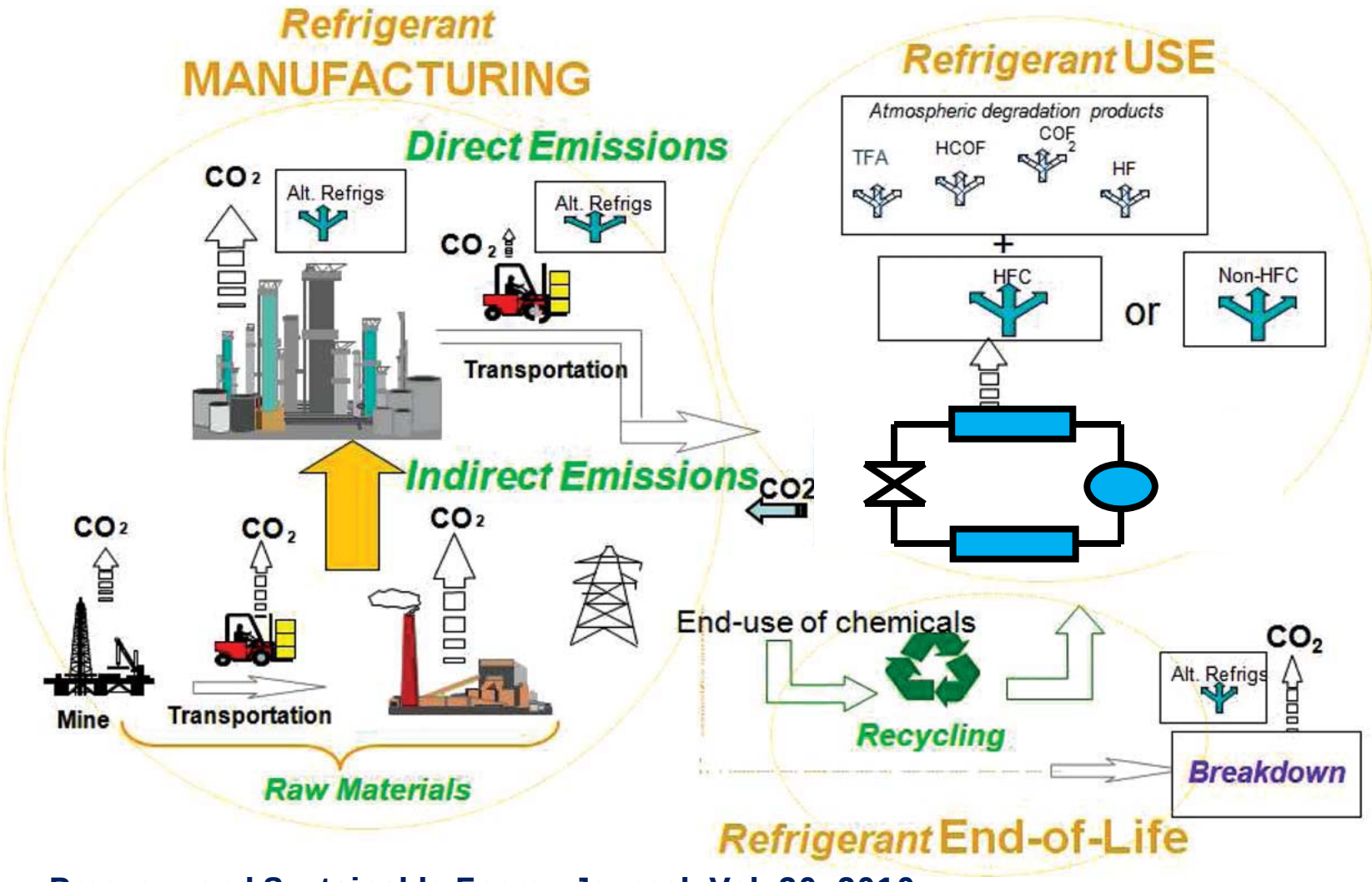
IIR Working Party on Life Cycle Climate Performance Evaluation

Yunho Hwang, Ph.D.
Chair of LCCP WP
Vice President of Commission B1

Agenda

Topic	Speaker	Time
LCCP WP Overview	Yunho Hwang	13:30-14:00
Refrigerant / sector advice matrix NVKL	Coen van der Sande	14:00-14:30
Life cycle performance of refrigeration systems in the Dutch supermarket sector (TP-085)	Carlos Infante Ferreira	14:30-15:00
Life cycle performance of refrigeration systems in the Dutch food and beverages sector (TP-086)	Hans Wijbenga	15:00-15:30
Discussion on further steps WP	Yunho Hwang	15:30-15:50

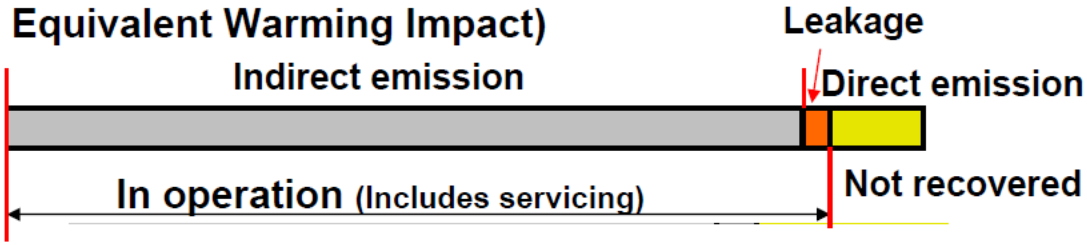
Environmental Impacts of Refrigerants



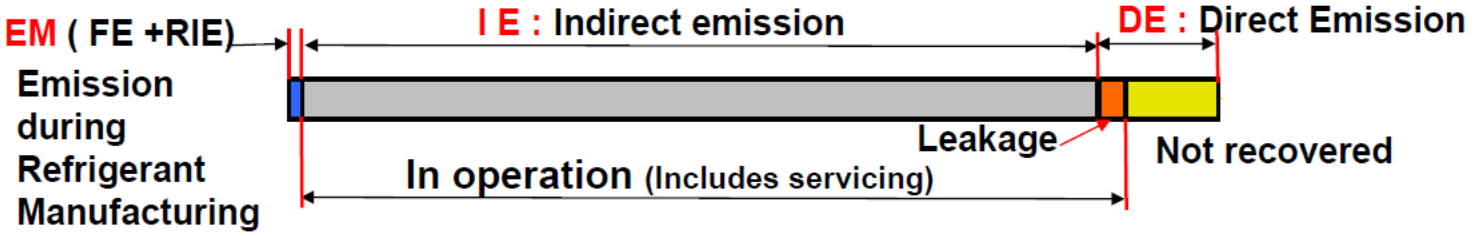
Progress and Sustainable Energy Journal, Vol. 30, 2010.

Some Metrics

TEWI (Total Equivalent Warming Impact)



LCCP (Life Cycle Climate Performance) "Simple comparison for refrigerant"



LCA (Life Cycle Assessment- $LCCO_2$)

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):

TEWI = GWP (direct) + GWP (indirect)

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

LCCP (Life Cycle Climate Performance):

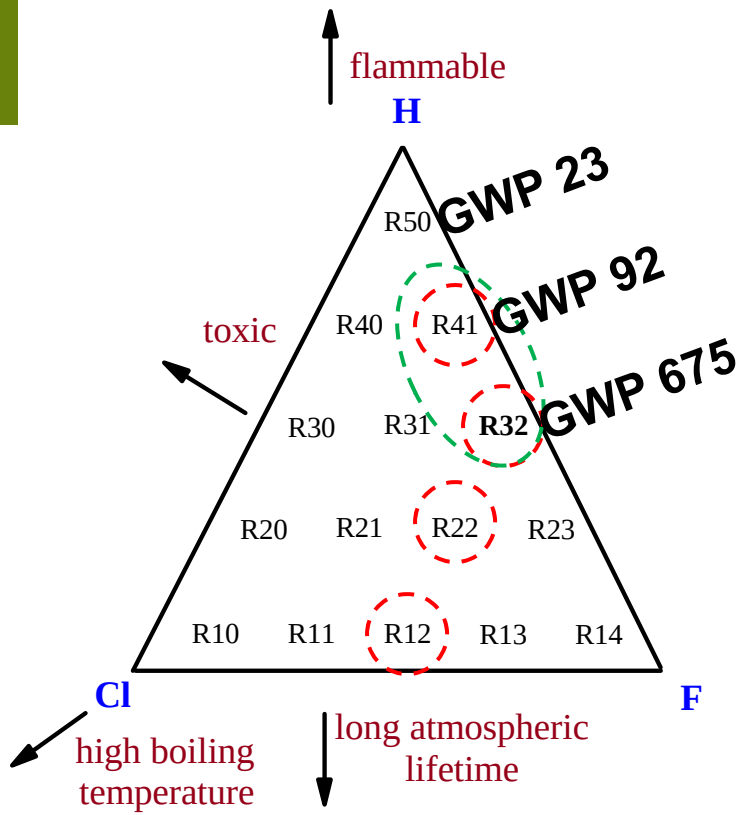
LCCP = TEWI

+ *GWP (Indirect)* [energy consumption expressed as CO_2-eq emissions from chemical production & transport, manufacturing components & product assembly and end-of-life]

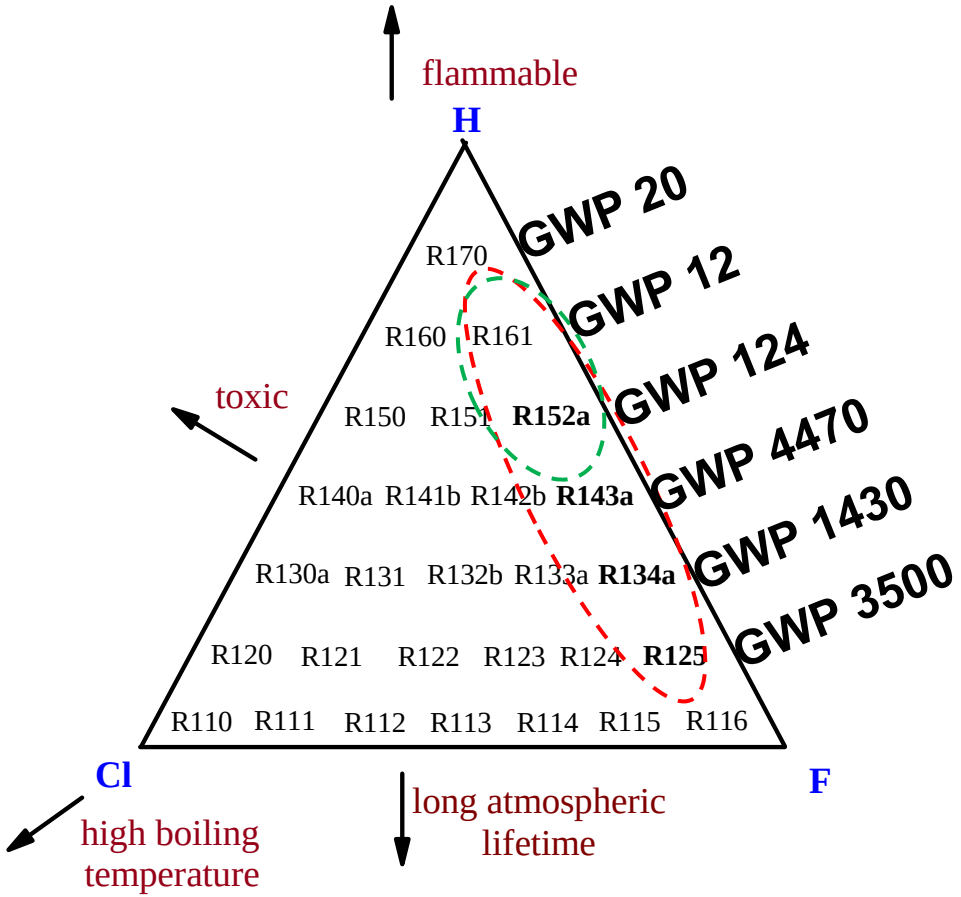
+ *GWP (direct)* [chemical refrigerant emissions including atmospheric reaction products, manufacturing leakage, and end-of-life]

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

Properties of Carbon Based Refrigerants

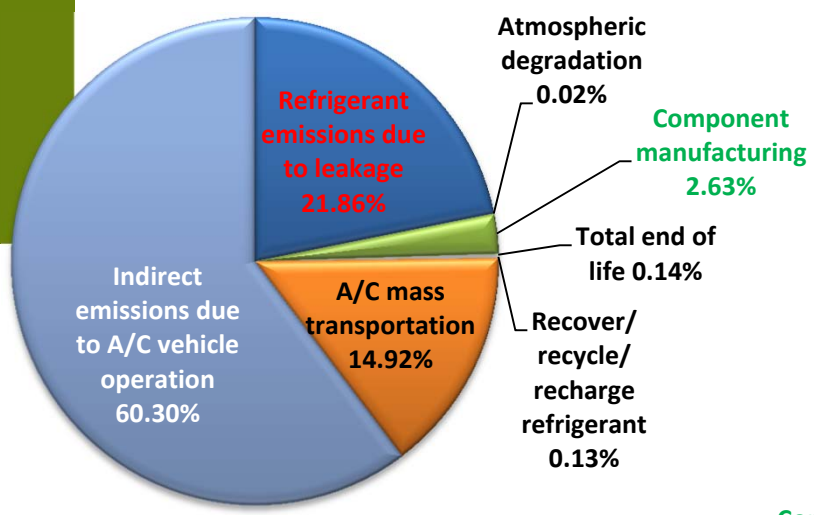


(a) Methane series

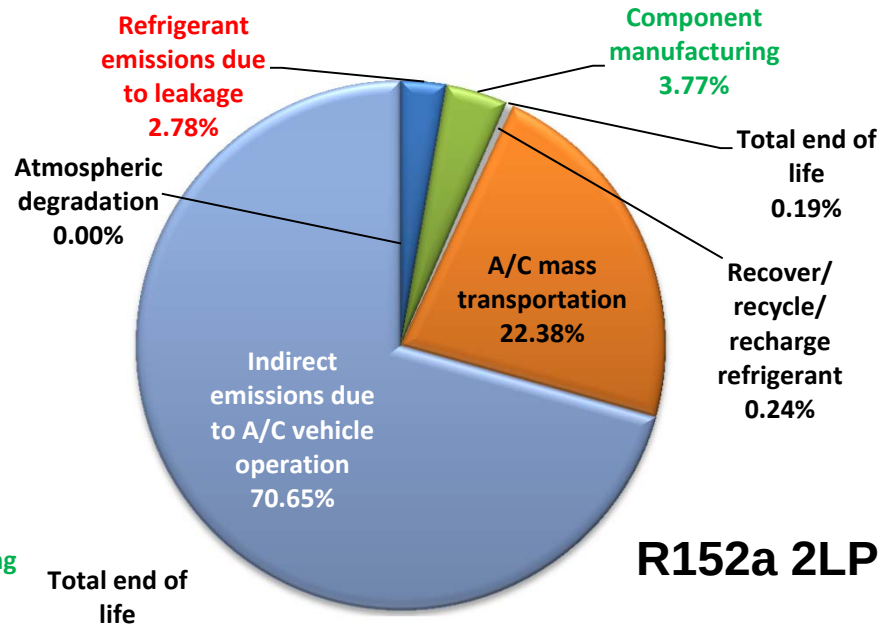


(b) Ethane series

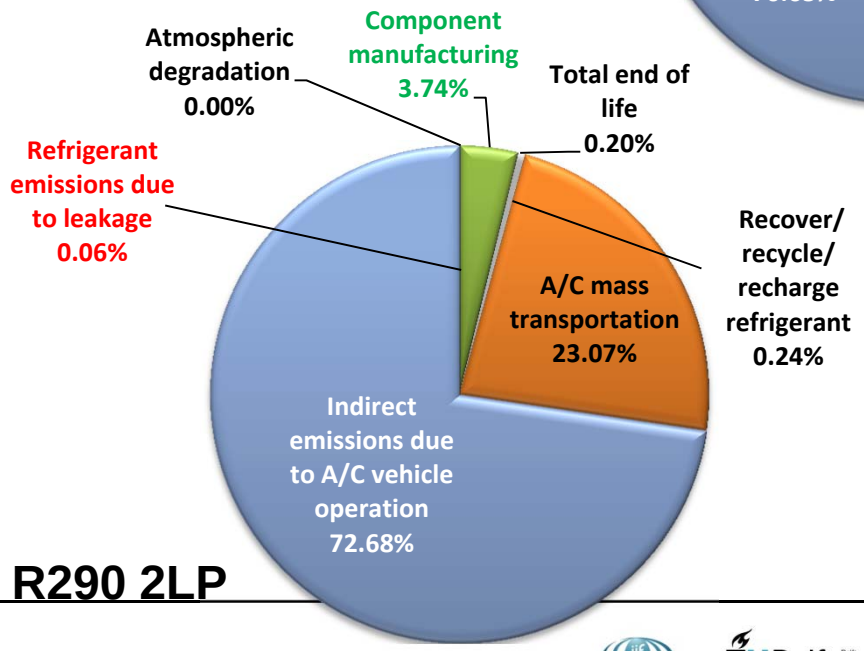
LCCP Contributions: MAC



R134a Baseline

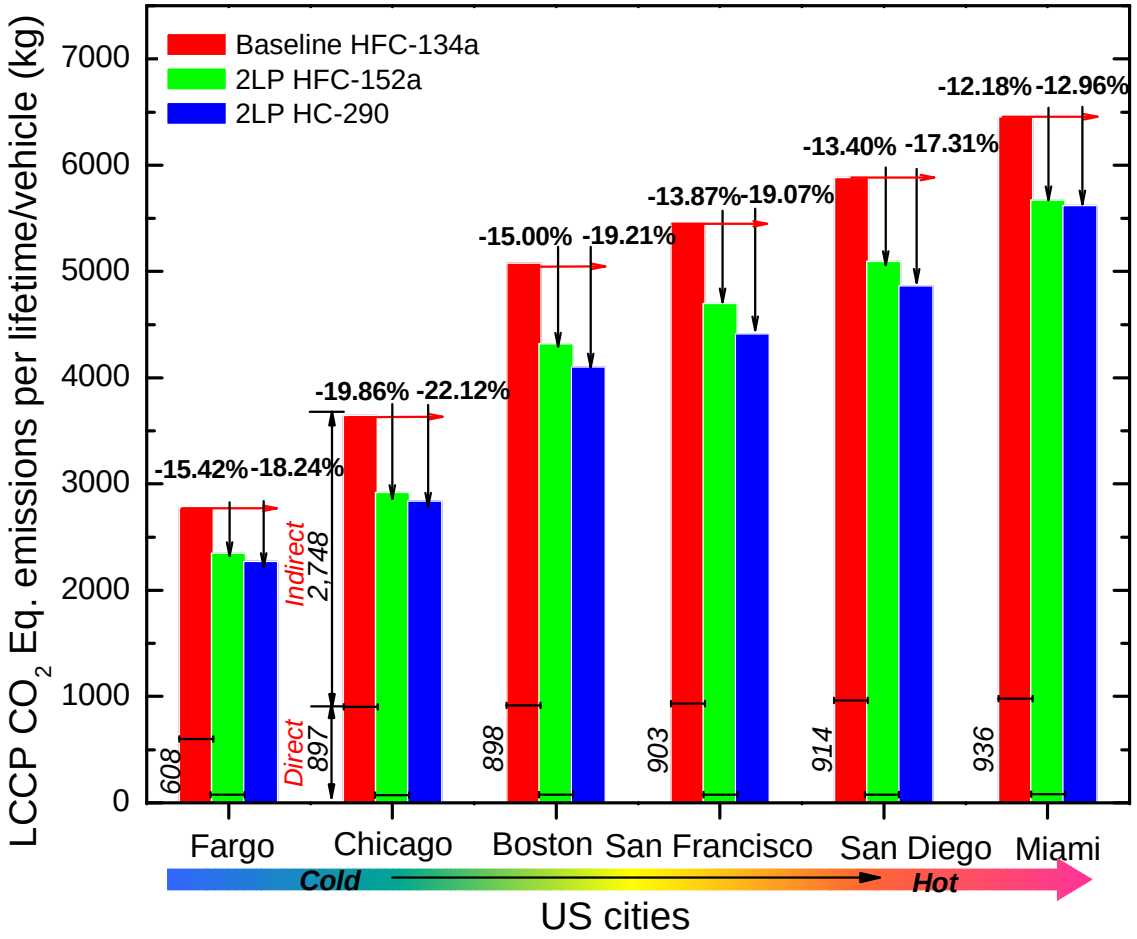


R152a 2LP



R290 2LP

LCCP Comparison: MAC, US Cities



Tools Available

- **GREEN MAC LCCP (2004) – Excel based**

GREEN-MAC-LCCP©

The Metric for MAC Environmental Superiority

- **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
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)			

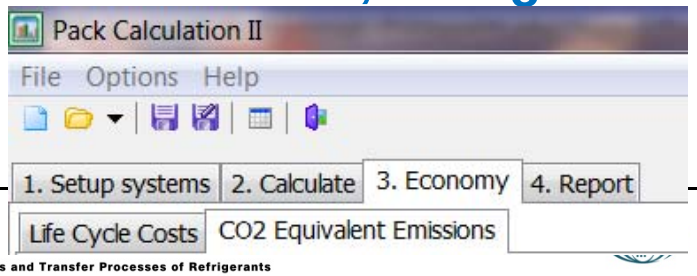
- **ORNL's Supermarket Refrigeration LCCP (2012) –Web based**

Life Cycle Climate Performance - Supermarket Systems V0.24

OAK RIDGE NATIONAL LABORATORY ETSD

CEEE

- **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

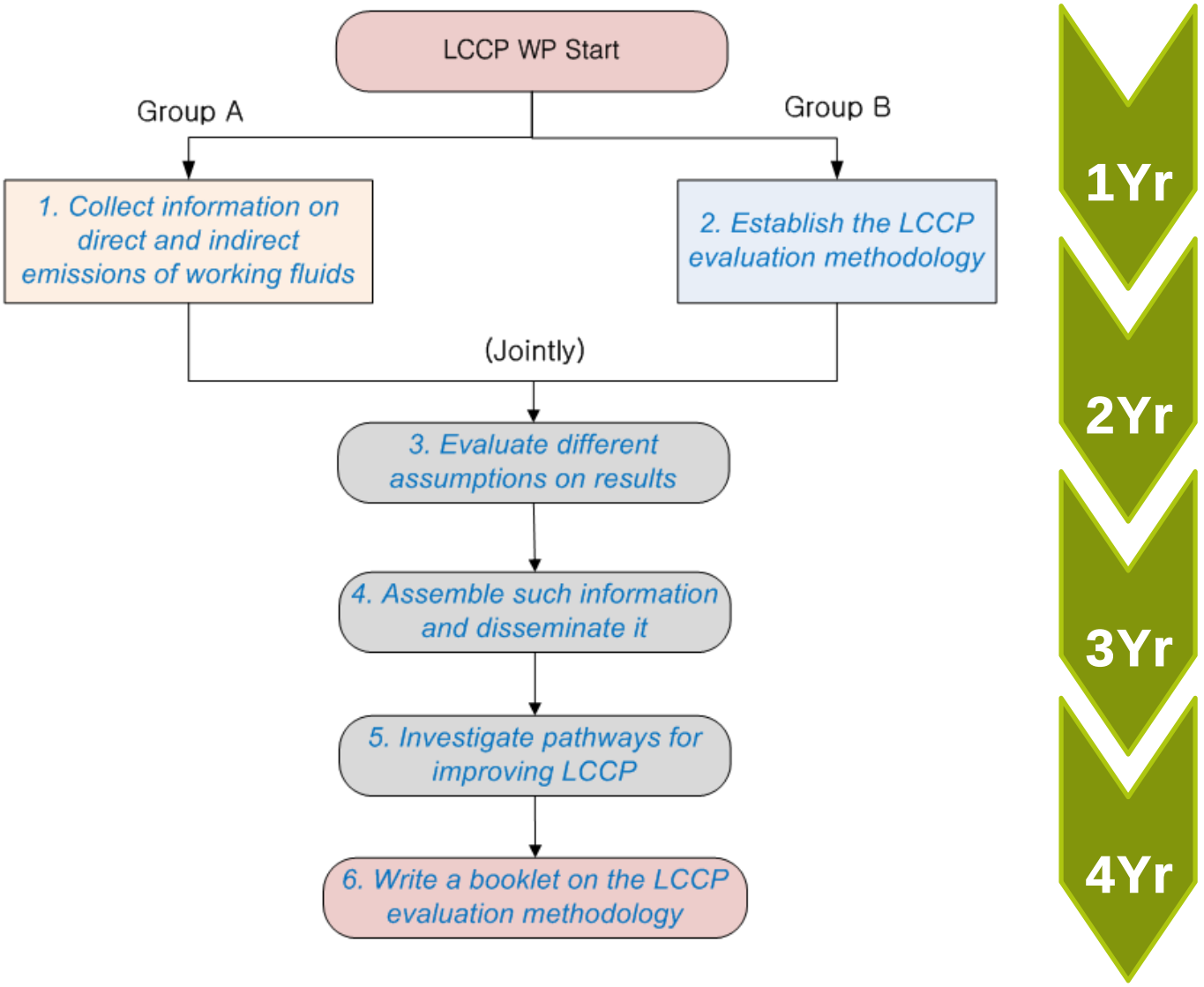
- Evaluate how improvement options can affect the result of the assessment.
- Assemble such information and to disseminate it amongst WP members and all IIR member states
- Write a booklet on the LCCP evaluation methodology developed and make it available to members of the WP and all IIR members, and 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
- Second WP meeting: Gaithersburg, October 2012, during the ASHRAE/NIST Refrigerant Conference
- 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

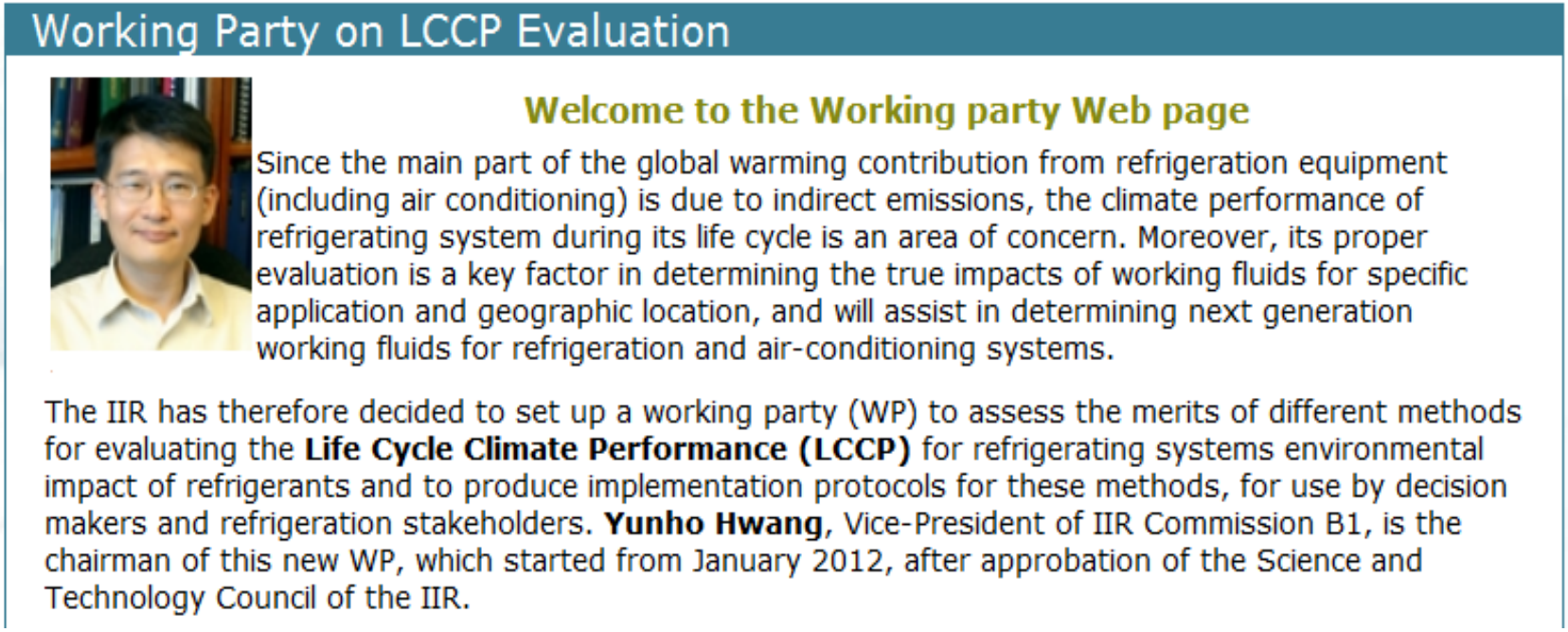


LCCP WP: Deliverables

- **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

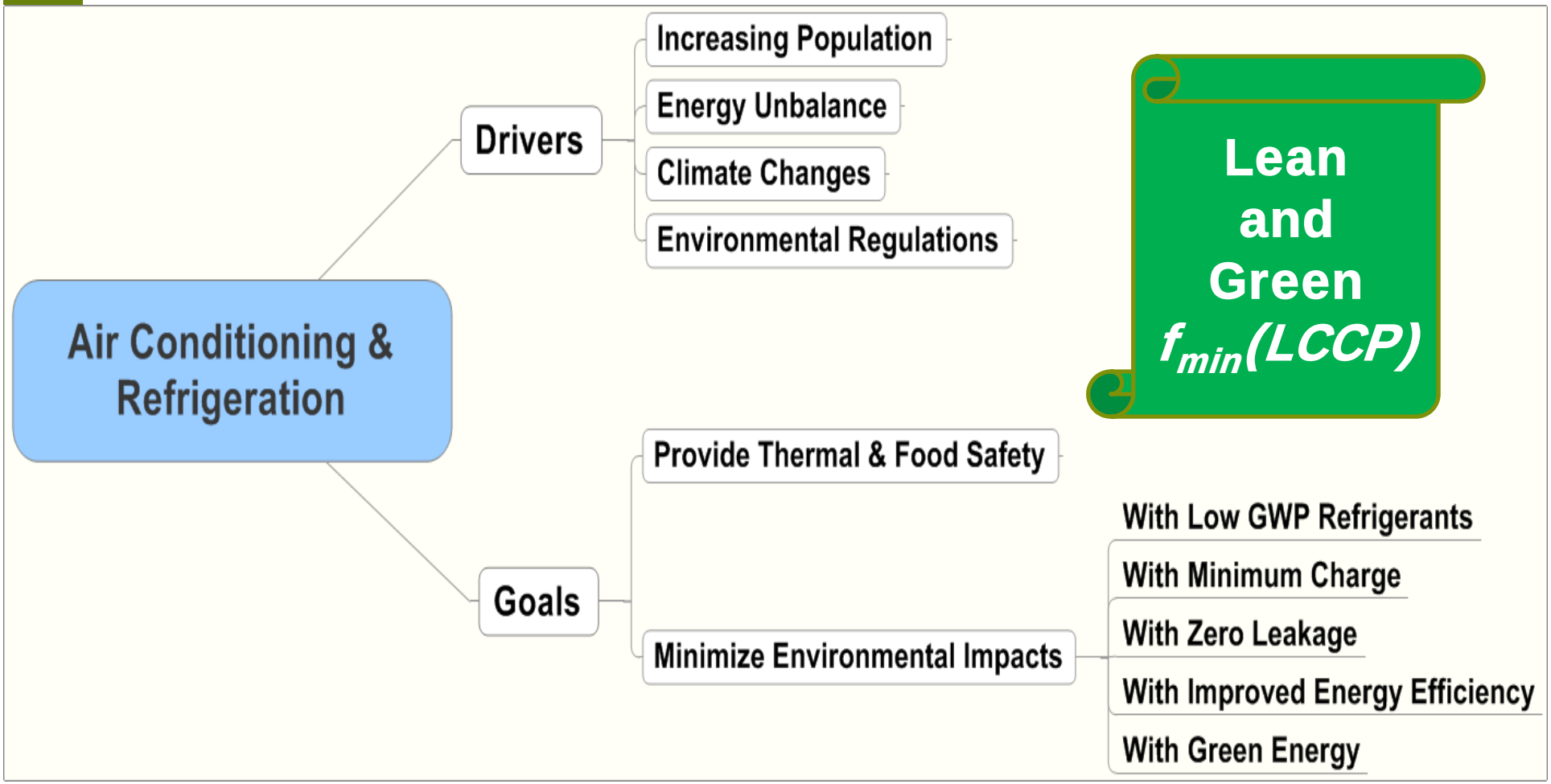


LCCP WP: Membership

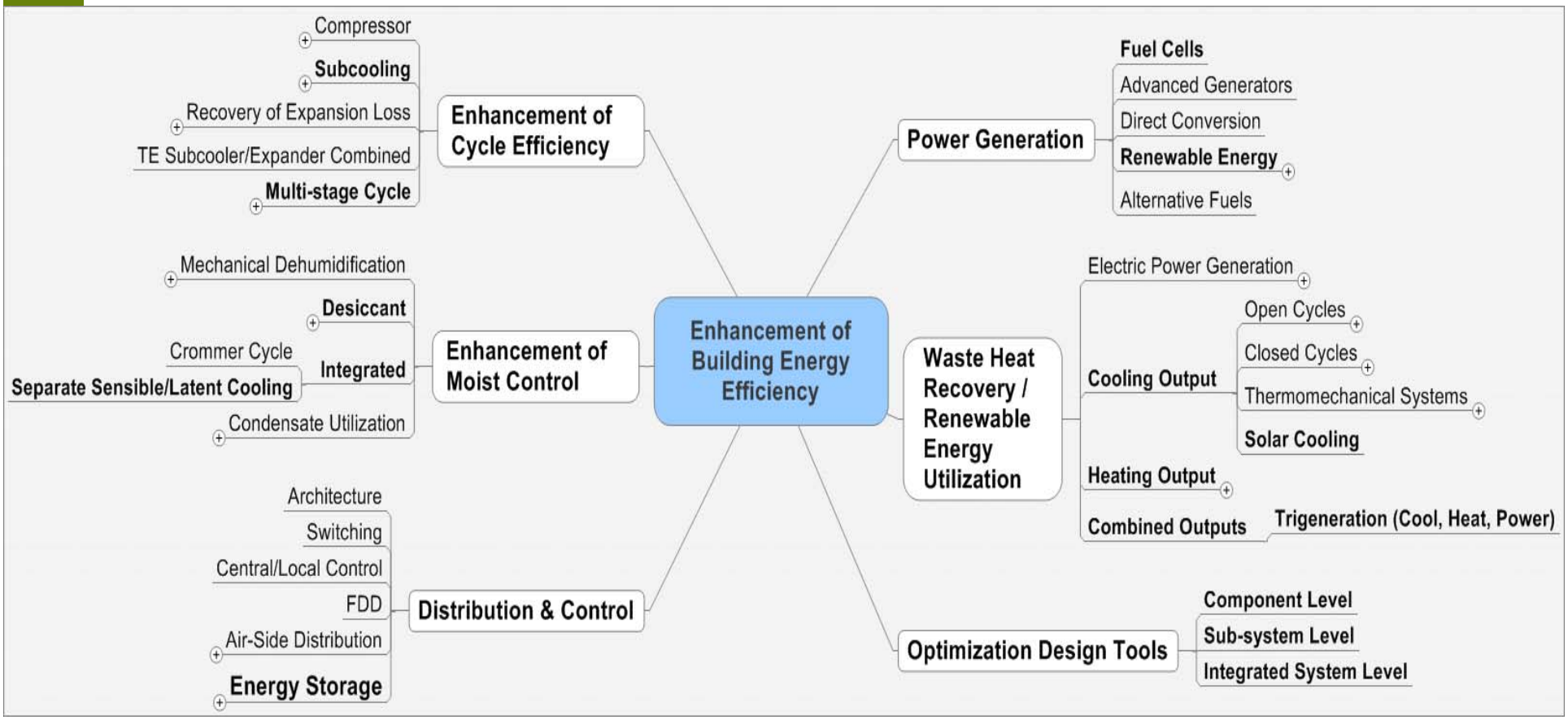
- Membership of the Working Party should be multi-national and open to private members or representatives of corporate members of the IIR.
- The IIR is currently recruiting members from following areas for this WP:
  - Commission, private, and corporate members of the IIR
  - Experts whose knowledge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

You are invited!

Our Goals


Air Conditioning & Refrigeration
Drivers
Increasing Population
Energy Unbalance
Climate Changes
Environmental Regulations
Goals
Provide Thermal & Food Safety
Minimize Environmental Impacts
With Low GWP Refrigerants
With Minimum Charge
With Zero Leakage
With Improved Energy Efficiency
With Green Energy
Lean and Green
$f_{min}(LCCP)$

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.

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