Transformation pathways for safe and sustainable refrigeration.

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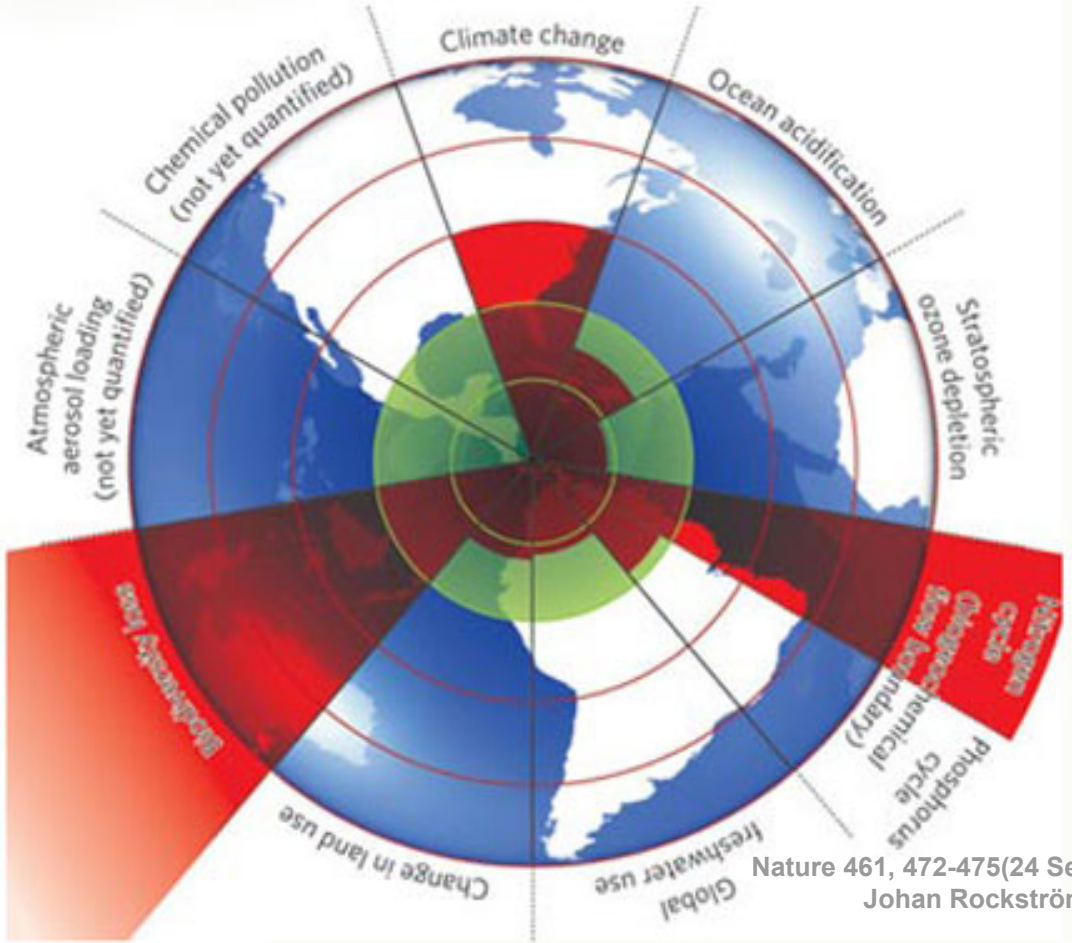
Mankind is the dominating geological force in the earth system (Paul Crutzen)

- Three of nine interlinked planetary boundaries already overstepped
- Crossing biophysical thresholds could have disastrous consequences



Nature 461, 472-475(24 September 2009)
Johan Rockström et al

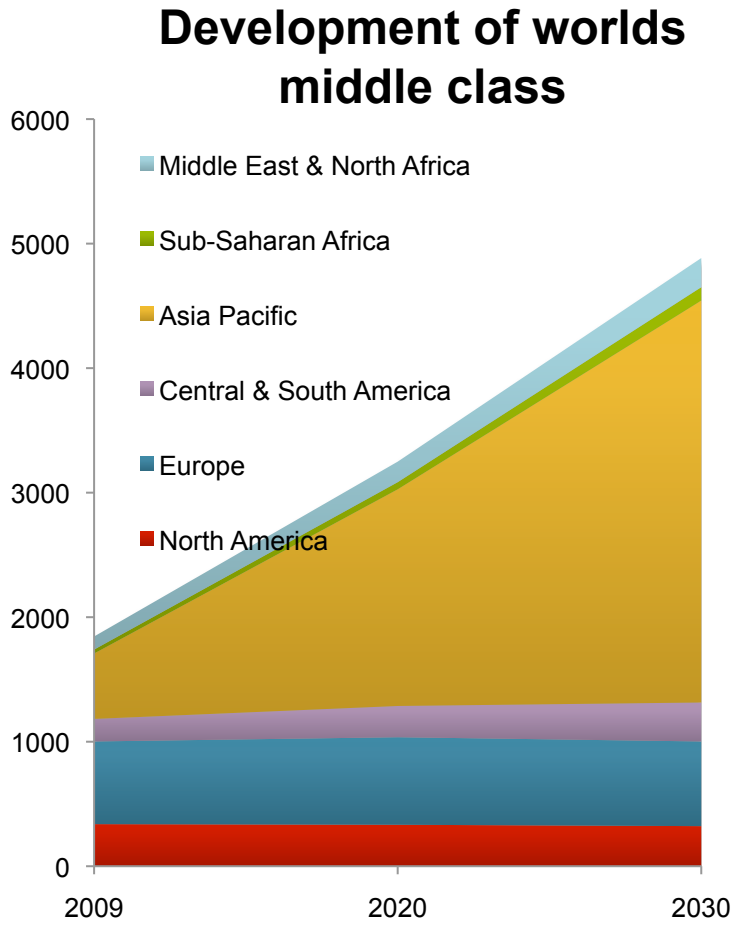
<u>RAC Sector impact on</u>

- Ozone and Climate --
- Chemical Pollution (persistent wastes) -
- Basic biochemical cylcles (fluor) -
- Biodiversity (food chains) +

MP applied precautionary approach in 1982-1987 when ozone depletion was still not scientifically proven

Is it possible to scale up existing growth patterns?

- > 9 bio people in 2050, GDP triple until 2030
- 80% of consumers are in DC and emerging economies, OECD share drops from 55 to 20% (2030)
- RAC market today ~ 200 bio. US $, AC demand growths by factor 14 until 2050 (IEA)
- Pressing time constraint to avoid tipping points
- Need to secure valuable planetary resources for future generations
- Developing countries are in the process to replace HCFCs, HFCs are not sustainable



→ Choosing sustainable alternatives is essential to reach the common goals

Scaling up depends on the sustainable systems and behaviour

Strategies

- Decarbonisation of energy supply
- Reduce, reuse, recycle materials
- Use of renewable materials
- Establish environmental safe systems and behaviours
- Accelerate innovation cycles
- Eliminate use of environmentally critical substances

→ **Choosing natural alternatives is a precautionary approach for transformation, in terms resource efficiency and environment**

Transforming to a knowledge based economy

- Resolving complexities is a typical starting point of sustainable technologies
- Safety & best practice is not refrigerant specific, it is a general requirement when competently managing RAC systems
- Continued education and knowledge sharing is essential for transformation, e.g. engineers, technicians, mechanics require to update their knowledge and need to learn to think systems.

Lessons learned:

- HC refrigerators just one example for global acceptance, incl. know-how & infrastructure, RefNat example in commercial refrigeration
- **Establishing qualification and controls for safe behaviour is essential for public safety when introducing sustainable alternatives**

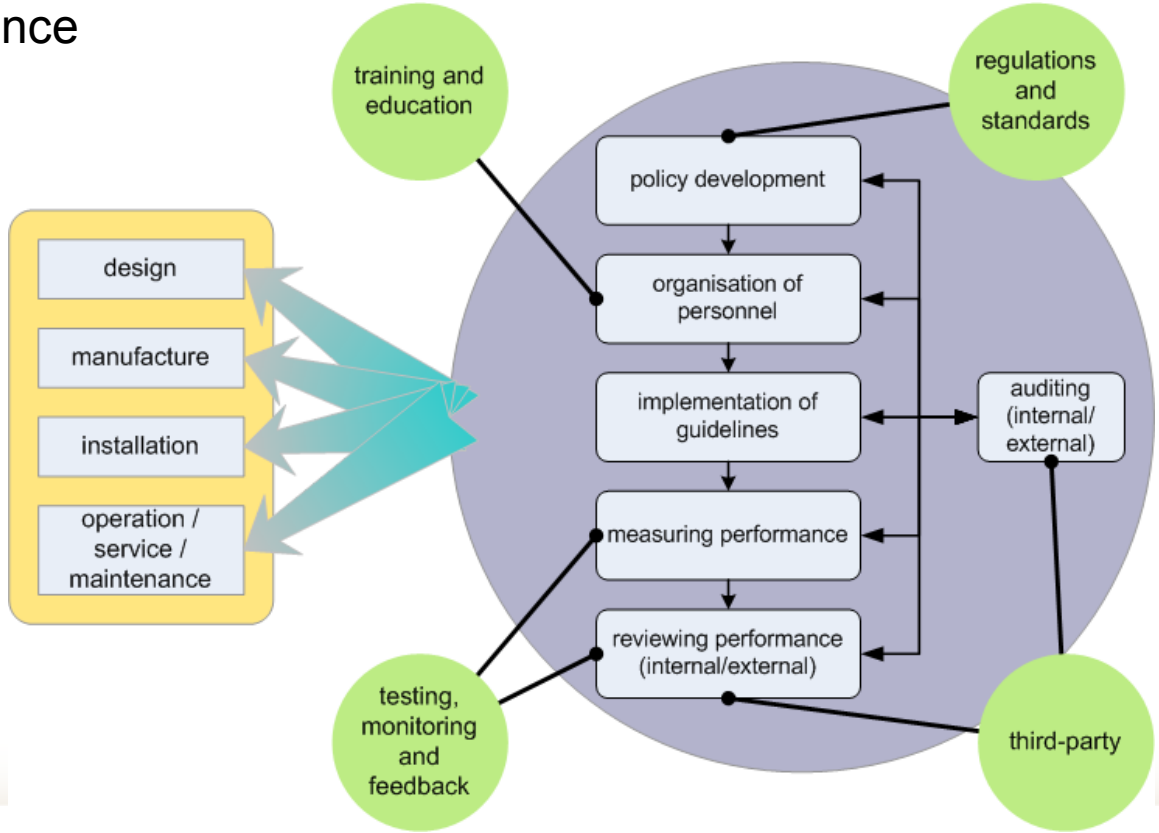
Key factors of safety management

Required changes and instruments :

- Innovative technology/know how → demonstrate application
- Awareness → provide information
- Education → build competence
- Skills → practical guidance

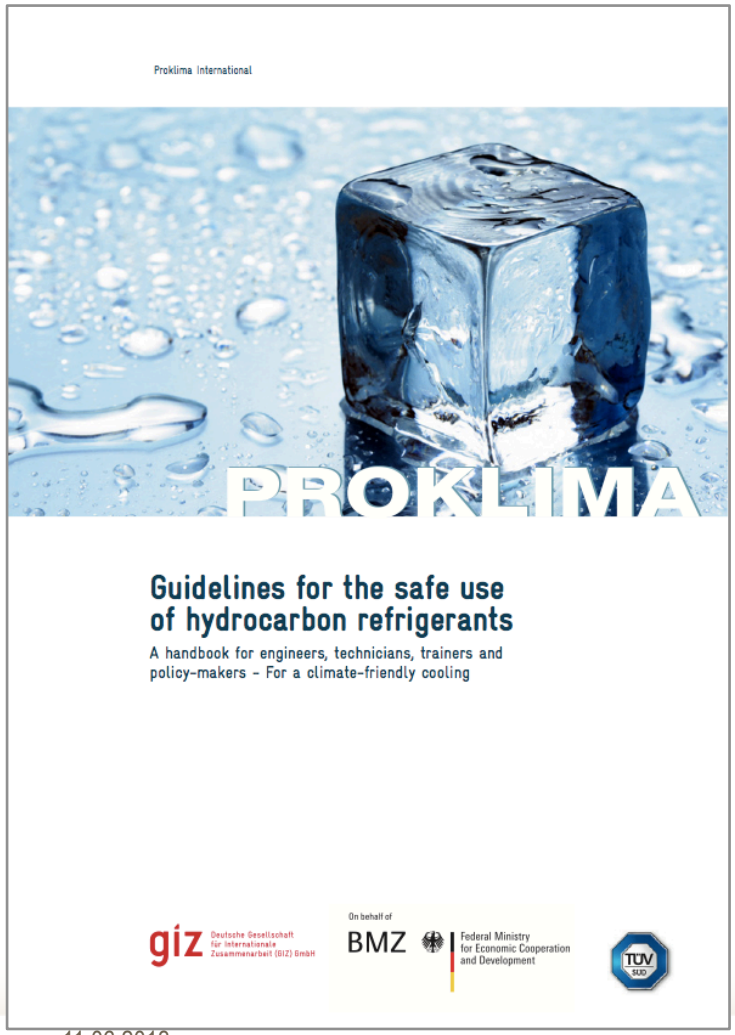
- **Behavioral aspects**

- Normative action
→ certification/registries
→ regulation/standards
→ quality assurance
→ monitoring
→ enforce controls



GIZ series on safe use of natural refrigerants

More than 30 national training programmes under MLF since 1996



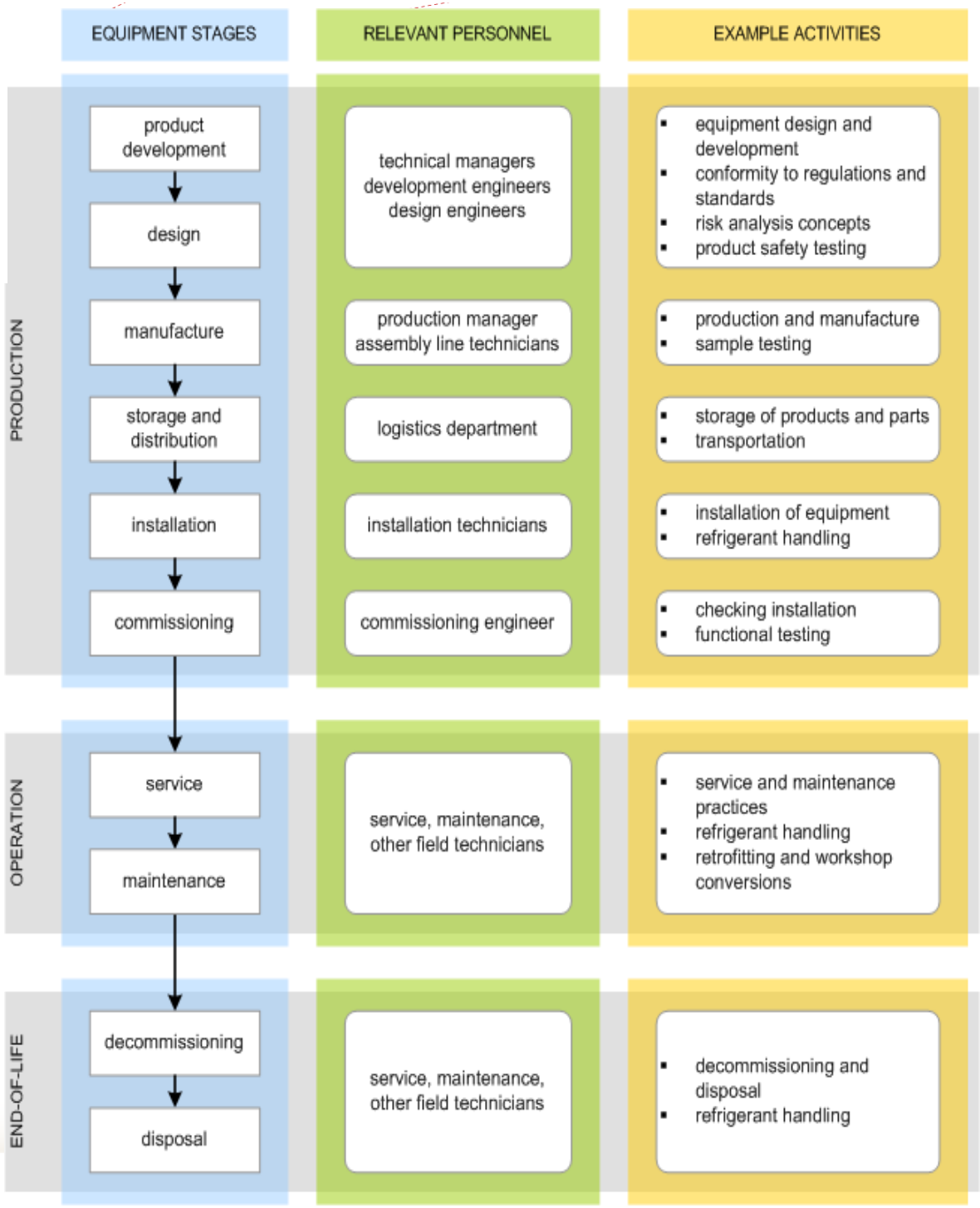
Building capacity throughout the value chain

Transformational Education:

Know what? → Informal

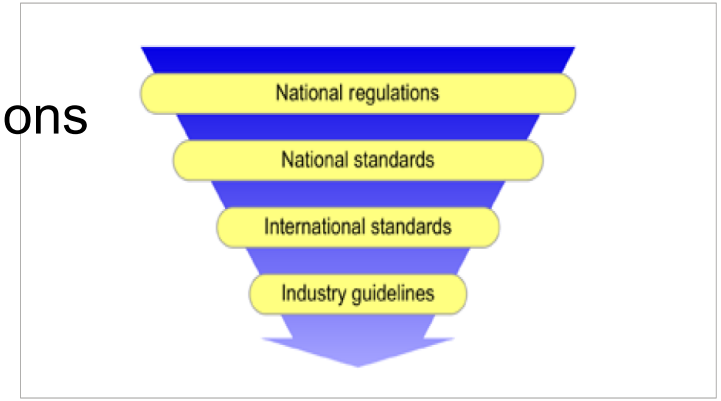
Know how ! → Formal

Know why ... → Competent Person

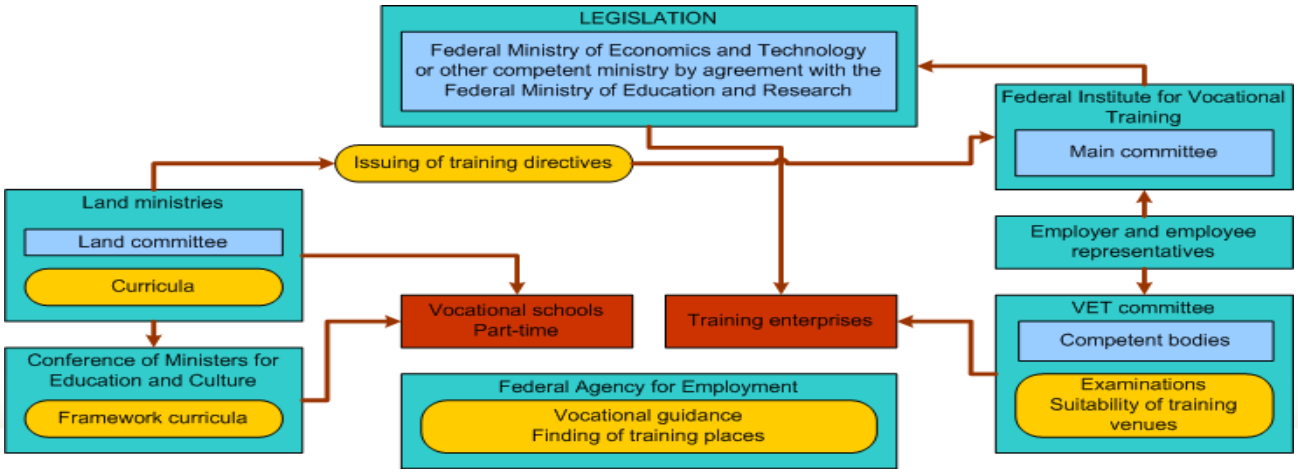


Building capacity throughout organisations

- Industry associations
- Technical/vocational institutes and associations
- Development and funding agents
- National authorities
- Standardisation bodies
- Accreditation bodies /quality assurance
- Research institutions and others ……



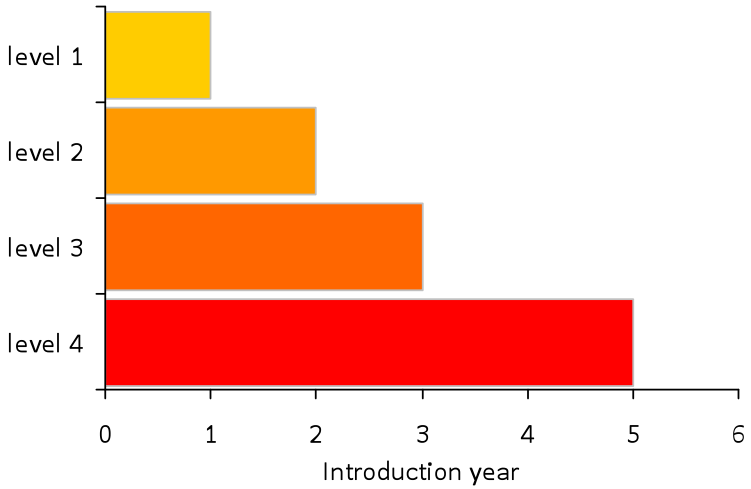
Integration with national stakeholder processes is essential for sustainability of activities



Time frame needs to be adjusted

System categories	Risk rating (Low, Medium, High)					Overall risk level
	charge size	number of SOIs	Simi-larity	external	other items	
Domestic refrigeration	L	H	L	H	L	level 2
Retail refrigeration						
▪ Integral (stand-alone)	L	M	M	H	L	level 2
▪ Split (condensing unit)	M	M	H	M	H	level 4
▪ [Central direct expansion]	H	H	H	M	H	[level 4]
▪ Central indirect	M	L	L	L	M	level 2
Air conditioning						
▪ Integral (window/ portable)	L	L	L	H	L	level 1
▪ Split	L	L	L	M	L	level 1
▪ Close control	M	H	M	M	M	level 3
▪ Rooftop unit	M	M	M	M	M	level 3
▪ [Ducted direct expansion]	H	H	H	M	H	[level 4]
▪ [Multi-split]	H	M	H	M	H	[level 4]
▪ Chiller	H	L	L	L	M	level 2
Transport						
▪ Car air conditioning	L	L	L	L	L	level 1
▪ Transport a/c	M	M	H	M	L	level 3
▪ Truck refrigeration	M	M	M	L	M	level 2
▪ Fishing vessels	M	M	H	M	M	level 3
Food processing, bespoke	H	M	H	M	H	level 4

Capacity building activities need to start as early as possible. Suggested timescale for the staged introduction of HC refrigerants according to risk level



Example: Brazil best practice

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Challenges

- Target 30,000 - 26,000 officially certified during NPP
- 80% of workshops „informal“ or „selfemployed“
- huge geographical area, remote areas with low or no access to qualification
- culture of training on the job, formal education low
- RAC vocational training concentrated in large centres
- national standards not developed
- High leakage, low carbon intensity of electricity

Approaches

- registration and certification system
- mobile training for decentral course system
- integrating with national training agents
- preference to practical training
- integrate contents in formal education
- adapted materials (visualized manuals)

Contd.: Brazil HPMP phase out

- First step: emphasis on leak control before putting any new refrigerants in the market
- National standards and regulations for recycling and take back of equipment adopted
- More integration with the private sector, workshops on training and design
- Integration of national research institutions, vocational and industry associations
- Introduction of documentation systems for servicing
- Pilot introduction e-learning, online documentation and info systems
- Modular training on soldering & leak control and best practice
- End user consultation (commercial) for replacement
- Stakeholder consultations on national framework
- Focus on certification of best practices principals

Conclusions

- Training has to be seen in the context of ongoing transformation of global economies; this takes time, better start early as possible
- Despite the “burning” issues of introducing new refrigerants, a culture of continued education and knowledge sharing in RAC sector is necessary
- In many countries formalization of education and certification to take place
- Capacity building not restricted to servicing personnel, integration with value chain and public stakeholders essential
- Public support insufficient, initiative and cooperation from private sector stakeholders required. Transnational technology cooperation specifically beneficial.

- Newly acquired competences develop multiple benefits:
  → higher energy efficiency from better practice (15 % +, EU)
  → less wastes and operational failure - better economy
  → customers understand value and pay for it
  → local supplies of natural refrigerants, no dependence on imports
  → enhances local know how and production options
  → longer term application of framework and know how
- High safety standards may generally improve services & performance
- Cash saved during operation could be used to pay qualified workers

Sustainable practice provides sustainable income!

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Thank you for your attention!

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On behalf of

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