



Presentation of the CAETS Energy report “Towards Low-GHG Emissions from Energy Use in Selected Sectors”

Yves BAMBERGER

**Vice-President of the National Academy of Technologies of France
2021-22 Chairman of the CAETS Energy committee**

Royal Academy of Engineering, Madrid, 2023, March 21



The French Academy of technology

« For reasoned, chosen and shared progress »

- Founded in 2000 from the Academy of Sciences
- Around 300 members
- 9 « Poles »

Health and Food

Housing and Mobility

Education and training

Industry and Services

Culture and Leisure

Technology and Economy

Energy

Environment & Climate Change

Digital

« TOWARDS LOW-GHG EMISSIONS FROM ENERGY USE IN SELECTED SECTORS »

The FOCUS:

- **ALREADY AVAILABLE and AFFORDABLE TECHNOLOGIES for DEPLOYMENT**
- **COMMENTS, MESSAGES and RECOMMENDATIONS to advise policymakers, industry and academic leaders**

TOWARDS LOW-GHG EMISSIONS FROM ENERGY USE IN SELECTED SECTORS

- **Executive summary** *Yves Bamberger (France)*
- **Chapter 0. To set the scene** *Yves Bamberger (France)*
- **Chapter 1. Food and agriculture** *Norman Roy Scott (USA) Patrick Caron (France)*
- **Chapter 2. Buildings and Smart cities** *Pradeep Chaturvedi (India) Ulrich Wagner (Germany)*
- **Chapter 3. Oil and gas industry** *Amos Avidan (USA) Godwin Igwe (Nigeria)*
- **Chapter 4. Chemical industry** *Michaël Matlosz (France) Oscar Vignart (Argentina)*
- **Chapter 5. Cement industry** *Rui Cai (China) Neven Duic (Croatia)*
- **Chapter 6. Iron and Steel industry** *Woong-Seong Chang (Corea) Alvarez Pelegry Eloy (Spain)*
- **Chapter 7. ICT** *Erol Gelenbe (France) Brunilde Sanso (Canada)*
- **Chapter 8. Conclusions** *Yves Bamberger*
- List of the 69 authors from 20 countries ; list of other contributors, reviewers (internal – external)
- Annexes: data and information by countries and sectors

TOWARDS LOW-GHG EMISSIONS FROM ENERGY USE IN SELECTED SECTORS

- **Executive summary** *Yves Bamberger (France)*
- **Chapter 0. To set the scene** *Yves Bamberger (France)*
- **Chapter 1. Food and agriculture** *Norman Roy Scott (USA) Patrick Caron (France)*
- **Chapter 2. Buildings and Smart cities** *Pradeep Chaturvedi (India) Michael Wagner (Germany)*
- **Chapter 3. Oil and gas industry** *Amos Avishai (Israel)*
- **Chapter 4. Chemical industry** *Michael Wagner (Germany)*
- **Chapter 5. Cement industry** *Rudolf Wimmer (Austria)*
- **Chapter 6. Iron and Steel industry** *Rudolf Wimmer (Austria)*
- **Chapter 7. ICT** *Erol Gelenbe (France)*
- **Chapter 8. Conclusions** *Yves Bamberger (France)*
- List of the 69 authors from 20 countries,
- Annexes: data and information by country

More than 40 % of GHG emissions (CO₂ and CH₄)

Chap.0 To set the scene

The central role of low-carbon electrification (renewables, nuclear)

[Principal low-carbon sources: 1. Direct use of solar energy 2. Low-carbon electricity 3. Low-carbon hydrogen 4. CCS...]

Chap.0 To set the scene

The central role of low-carbon electrification (renewables, nuclear)

[Principal low-carbon sources: 1. Direct use of solar energy 2. Low-carbon electricity 3. Low-carbon hydrogen 4. CCS...]

- **Low-carbon technologies are available, and have often co-benefits**
- **Energy efficiency and rebound effect**
- **Synergies between uses and resiliency**
- **Importance of metrics**
- **Heat Pumps**
- **Hydrogen**
- **Life Cycle Analysis**

Chap.0 To set the scene

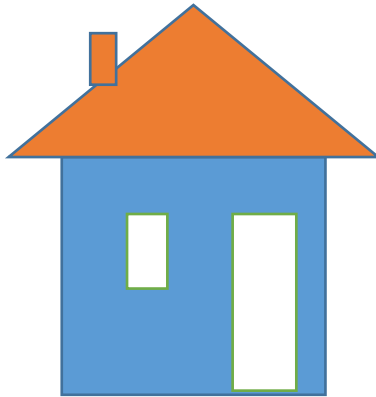
The central role of low-carbon electrification (renewables, nuclear)

[Principal low-carbon sources: 1. Direct use of solar energy 2. Low-carbon electricity 3. Low-carbon hydrogen 4. CCS...]

- Low-carbon technologies are available, and have often co-benefits
- Energy efficiency and rebound effect
- Synergies between uses and resiliency
- Importance of metrics
- Heat Pumps
- Hydrogen
- Life Cycle Analysis
- *Importance of holistic approaches*
- *Intrinsic difficulty due to the contradictory interests...*
- *Stability and predictability of regulatory changes*
- *Benchmarking*
- *Skills and competencies (old ↘ ↗ ↻, new)*
- *Effective leadership and arbitration capacity*

The choice of metric : example of buildings

Energy efficiency first or low-carbon first?



Gas boiler

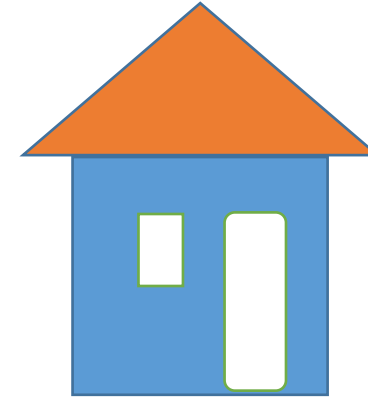
Emissions: $\approx 840 \text{ kgCO}_2$

Heating annual need

4 MWh

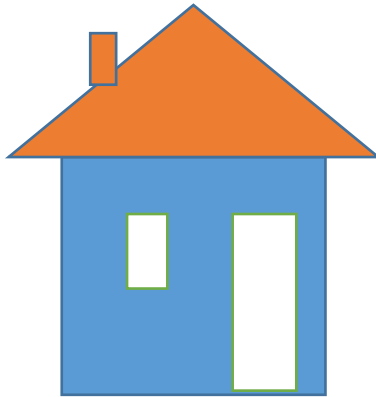
Spain electricity mix

$\approx 200 \text{ gCO}_2/\text{kWh}$



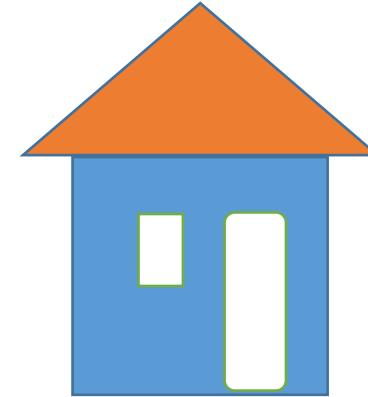
The choice of metric : example of buildings

Energy efficiency first or low-carbon first?



Gas boiler

Heating annual need
4 MWh
Spain electricity mix
 $\approx 200 \text{ gCO}_2/\text{kWh}$



Emissions: $\approx 840 \text{ kgCO}_2$

SOLUTION A: 50 % Insulation: $\approx 420 \text{ kgCO}_2$

SOLUTION B:

Electric heat pump with SCOP3

Emissions: $\approx 800/3 = 267 \text{ kgCO}_2$

Structure of the 7 chapters on sectors

- Executive Summary
- Introduction
- Current situation: world yearly GHG induced emissions by the sector
- Technologies for decarbonisation...
- Sustainability, public policies and regulation...
- Pathways to net-zero CO₂ emission/Different narratives...
- Education and training...
- Case Studies...
- Key Messages and Recommendations....

Chap.1 Food and Agriculture

- Around 26 -33 % of the total GHG emissions (principally methane)
- The Food and Agriculture System is a complex adaptive context-specific system interacting with water, energy, population, land-use, etc.

Key message

Decarbonisation and methane reduction imply trade-offs among diverging sustainability objectives and across time and space – scales: it needs to reinforce our capacity to address such issues.

Recommendations

- Possibilities for methane reduction from livestock (new feed additives,...) and rice cultivation (improvement in irrigation and use of fertilisers,...) already exist and have to be improved.
- Electrification « from farm to fork », including agrivoltaic, tractors, food processing and storage, is more and more possible.
- The benefits of alternative plant-based protein foods, 3D-printed food, advanced greenhouses and vertical farms have to be assessed through LCA and their societal consequences.

Chap.2 Buildings and smart cities

- Around 37 % of the total GHG emissions (taking in account the life cycle, for the operation: around 7 % directly and 21 % through electricity and heat consumption).
- Very different situations (poor/favoured people, emerging/industrialised countries): case study on carbon emissions reduction of a poor neighbourhood in Buenos-Aires for example.

Key message

Existing buildings (cities) and new buildings (cities) require different policies.

Recommendations

- Keys to new sustainable buildings (including materials)
- Well-balanced retrofits solutions to reduce emissions and energy-use at the lowest cost
- Electrification for decarbonisation and improved integration of renewables and flexibility (cooking, lighting, water heating, heating, cooling).
- Consider buildings as energy systems
- Smart cities to bring together smart buildings (for example: digitalisation)

Chap.3 Oil and Gas

Around 8 % of the total GHG emissions (CO₂ and CH₄) ***before the end-use***:
24 % of the total emissions from oil and gas.

Key messages

- Big facilities have a life spans of decades and are highly optimised from feedstocks to products for their markets.
- The ratio between energy and non-energy products will decrease.

Recommendations

- Strong emphasis on reducing methane flaring and fugitive methane emissions in all phases.
- Electrification as a substitute for the direct heating process streams.
- Use and improve LCA models to obtain realistic views of the choices.
- Continue to evaluate and develop the CCuS for oil and gas operations.

Chap.4 Chemical industry

- The chemical sector is responsible for around 5% of the total GHG emissions.
- Seven « primary chemicals » derived from petroleum products *as a feedstock*, for more than 70 000 products.

Key message

Major high-tonnage chemical production will not disappear in the next 20 years.

Recommendations

- Accelerate the reuse, reduction and recycling of carbon-based materials and reduce the use of nitrogenous fertilisers
- Replace when possible chemicals process by less emitting ones
- Electrify the process heating
- Develop large scale low-carbon hydrogen production for ammonia synthesis

Chap.5 Cement Industry

- The cement industry is responsible for about 7% of the total GHG emissions
- The chemical reaction (calcination using limestone) to produce standard cement is emitting by itself (50 % of the emissions) and needs some 1 450°C.

Key message

Cement is a cheap versatile and durable material used worldwide for construction and will continue doing so.

Recommendations

- Use the already available technologies for carbon reduction: energy efficiency, alternative fuels, low-carbon electricity
- Use and explore alternative raw materials.
- Develop and update benchmarks and standards for new cements.
- Promote close cooperation between cement and other industries.

Chap.6 Iron and steel industry

The steel industry is responsible for 7 to 9% of the total GHG emissions

Key message

- Steel is a versatile and durable material, with a wide range of applications and will continue doing so, produced by a capital-intensive industry.
- Blast Furnace/Basic Oxygen Furnace using coal represents still 73% of the production vs. 27% to Electric Arc Furnace using scrap.

Recommendations

- Expanding scrap use and improve new scrap processing technologies.
- Implement every possible and economically affordable CO₂ emissions reduction on existing facilities (partial electrification, use of low-carbon hydrogen, residual energies,...).
- Incentivise and promote demonstration plants to be able to deploy low-carbon industrial facilities in the 2030s or earlier.
- Support cooperation and partnership in the development of new technologies and sharing experience and costs in order to accelerate practical implementations.

Chap.7 Information and Communication technologies

In exponential growth, the ICT sector uses principally electricity (around 8 – 10 % of the worldwide consumption, eg. 2-2.5% of the total GHG emissions).

Key message

The expansion of ICT will continue, reducing emissions in some other sectors (?).

Recommendations

- Different solutions are already existing to minimize the increase of consumption coming from 5G technology.
- Keep improving the Data centre energy efficiency and consumption is possible.
- Improve the optimal replacement of ICT equipment to reduce ICT impact.
- Set public requirements and standards for the compilation and publication ICT energy consumption and emissions data.

Chap.8 CONCLUSIONS

Through the 2022 CAETS Energy Report:

- **We wish to emphasise that many technologies designed to reduce – and in some cases almost eliminate – GHG emissions are already available for immediate action in the key sectors and will require the availability of enough low-carbon electricity.**
- **We are aware of the many difficulties and conflicting interests involved in moving the world faster towards fewer GHG emissions.**
- **We insist on the importance of education and training, even more on the essential character of the involvement with citizens and public opinion.**
- **We are convinced that more interaction between our Academies and the CAETS with the policy makers, the industrial and academic leaders could be useful to facilitate the path toward lower GHG emissions.**





THANK YOU!

yves.bamberger@academie-technologies.fr

