SLC, 11th october 2023

Buildings Thermal management Materials Efficiency, Electrification, Decarbonation

Yves.Brechet@Saint-Gobain.com

With contribututions from JM.Combes, E.Gouillart, E.Normant

Prelude : The Big Picture

The “Big Picture” (1)

- **Energy sources**
  - Solar
  - Wind
  - Mechanical
  - Hydro
  - Coal
  - Gaz
  - Nuclear
- **Energy vectors**
  - Electricity
  - Hydrogen
  - Heat
- **Energy usage**
  - Industry
  - **Housing**
  - Transport

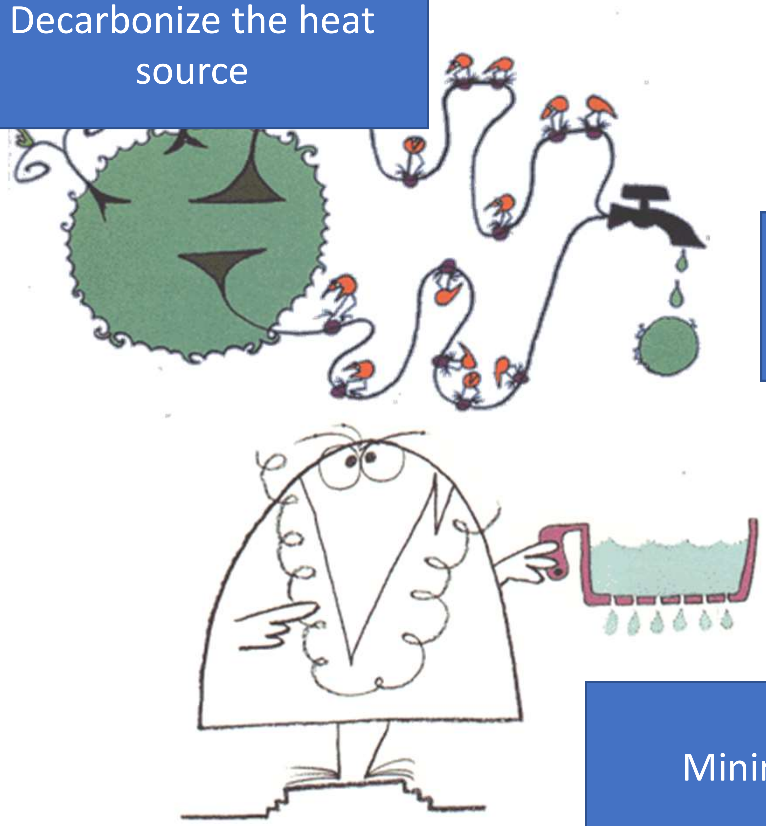
The “Big Picture” (2)

- **In order to produce, transport, and use energy we have to “make stuff”**
  - Energy production
  - Cables, pipes
  - Storage devices
  - Manufactured goods
  - **Building and insulation materials**

- **In order to “make stuff,” you need:**
  - space ,
  - energy
  - raw materials

- **In order to “make stuff,” in a sustainable way**
  - Sustainability of resources
  - Impact on the environment
  - Contribution to global warming

Decarbonize the heat source

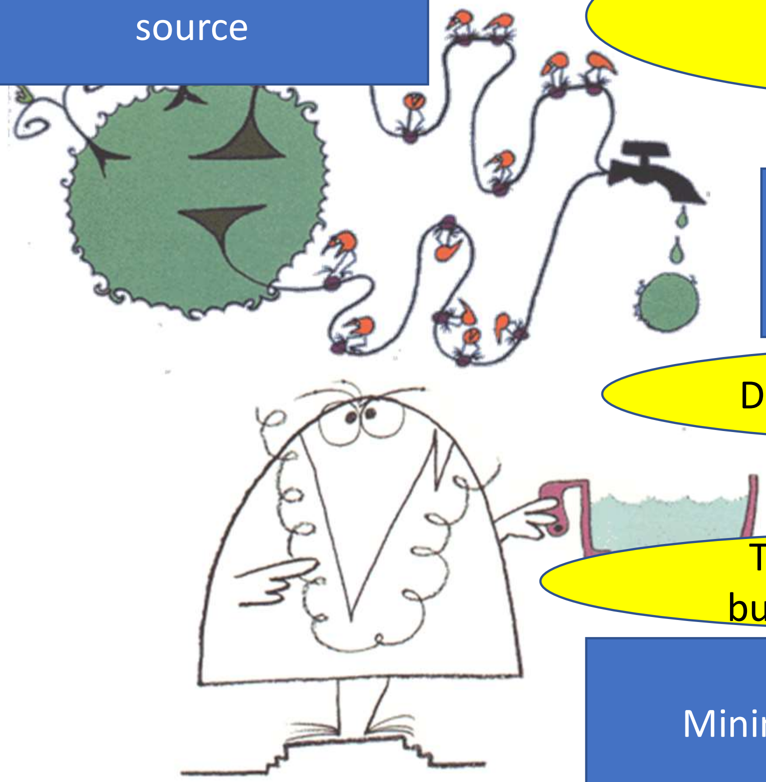


Monitor the heat source

Minimize the heat losses

Minimize the carbon footprint of the « hole fillers »

Decarbonize the heat source



Electrification of heating, decarbonization of electricity production

Monitor the heat source

Digitalisation of energy use

Thermally efficient buidings/ Renovation

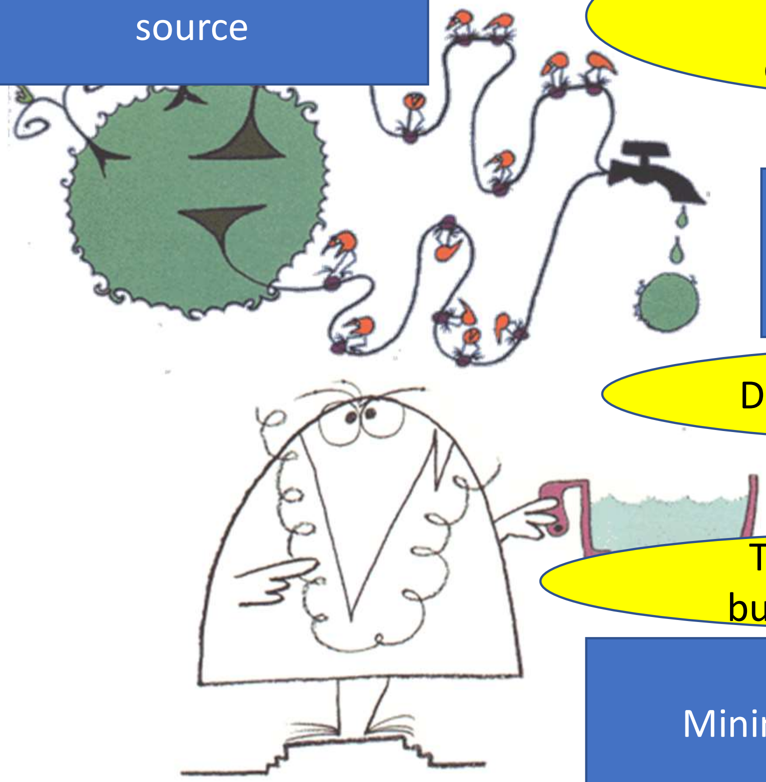
Minimize the heat losses

Minimize the carbon footprint of the « hole fillers »

CO_2 efficient processes

Decarbonize the heat source

Electrification of heating, decarbonization of electricity sproduction



Monitor the heat source

Digitalisation of energy use

Thermally efficient buidings/ Renovation

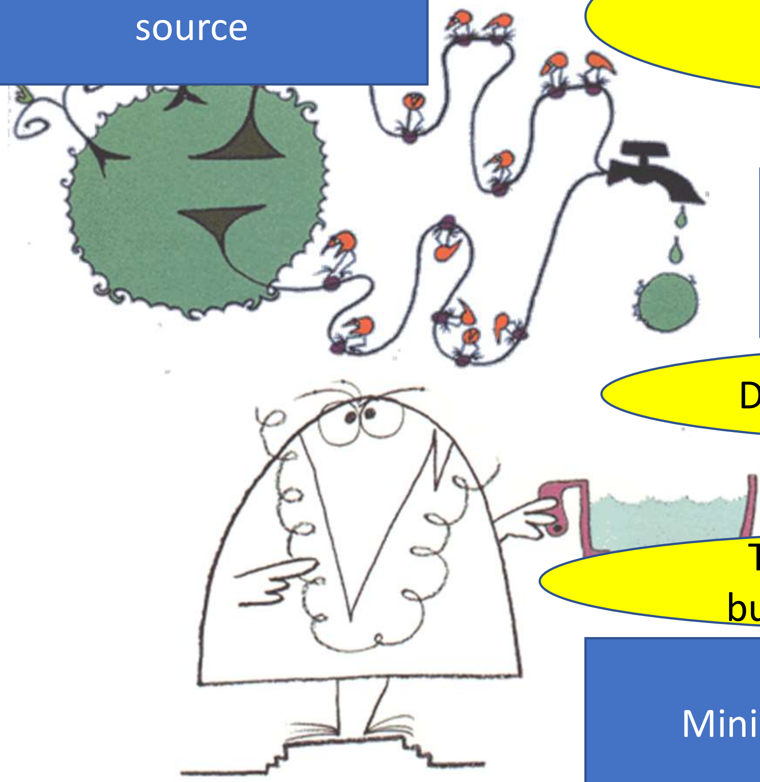
Minimize the heat losses

Minimize the carbon footprint of the « hole fillers »

CO2 efficient processes

- In France , Building represents44% of energy One can decrease by 80% energy loss in buildings by a proper heat management(thermal insulation and windows)
- If one decreases by 10% the energy consumption, it it is equivalent to 7 Nuclear powerplants…it can be done in 10 years, with existing technologies and materials which are locally produced and implemented
- The production of glass, plasterboard, insulation materials, can be at least partially electrified and decarbonized in the coming years

Decarbonize the heat source



Electrification of heating, decarbonization of electricity sproduction

Monitor the heat source

Digitalisation of energy use

Thermally efficient buidings/ Renovation

Minimize the heat losses

1

Minimize the carbon footprint of the « hole fillers »

2

CO2 efficient processes

- In France , Building represents44% of energy One can decrease by 80% energy loss in buildings by a proper heat management(thermal insulation and windows)
- If one decreases by 10% the energy consumption, it it is equivalent to 7 Nuclear powerplants…it can be done in 10 years, with existing technologies and materials which are locally produced and implemented
- The production of glass, plasterboard, insulation materials, can be at least partially electrified and decarbonized in the coming years

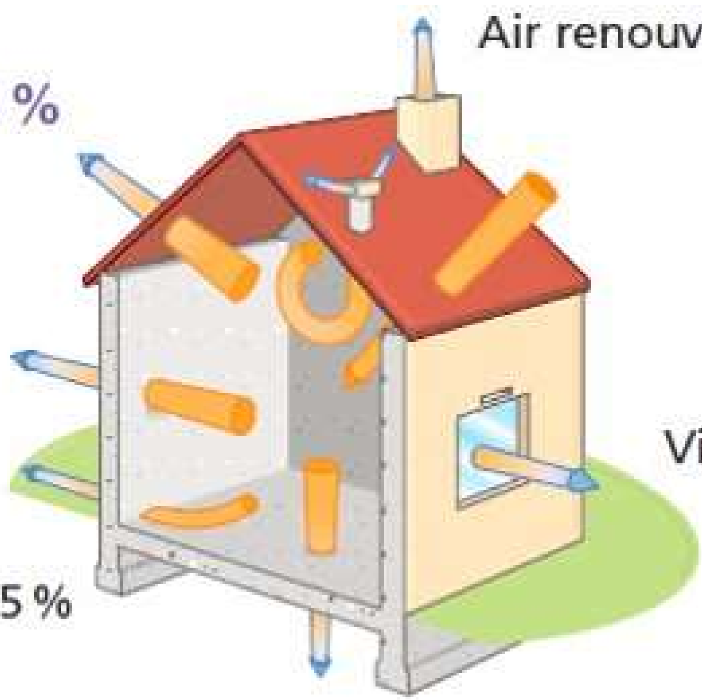

ISOVER

OUTLINE

- Minimizing Heat losses
- Decarbonizing Processes
- Developping process electrification
- Conclusions

Minimize Heat losses

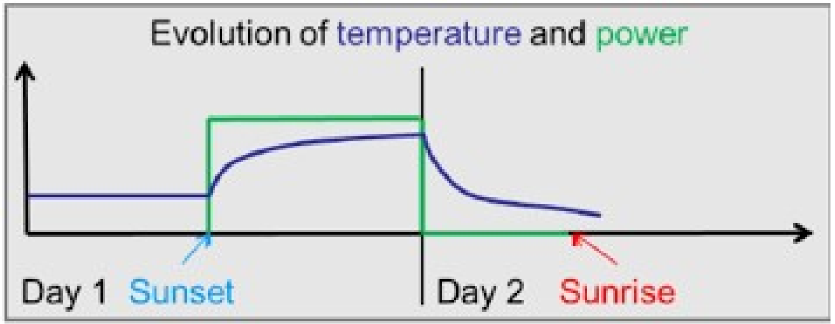
Thermal insulation for energy savings

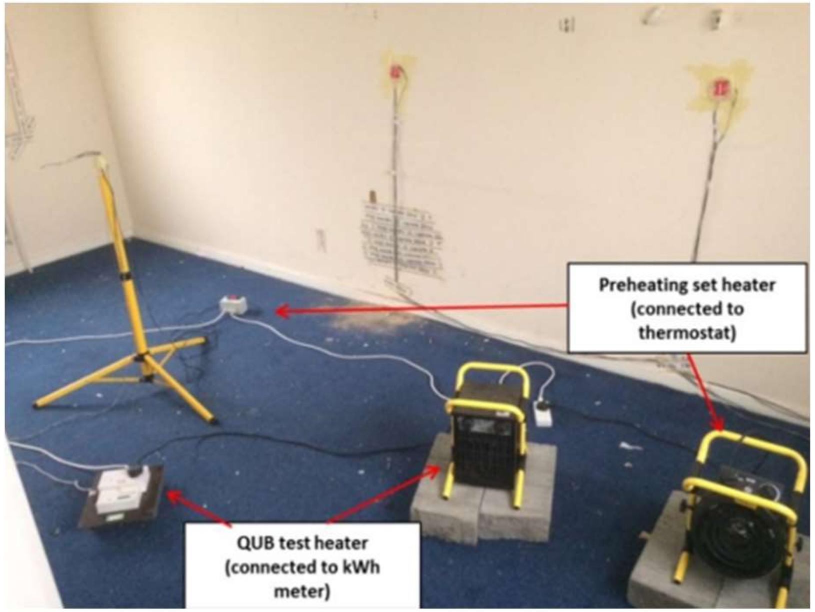


Source : FILMM

SAINT-GOBAIN

Quantitative diagnosis of building performance

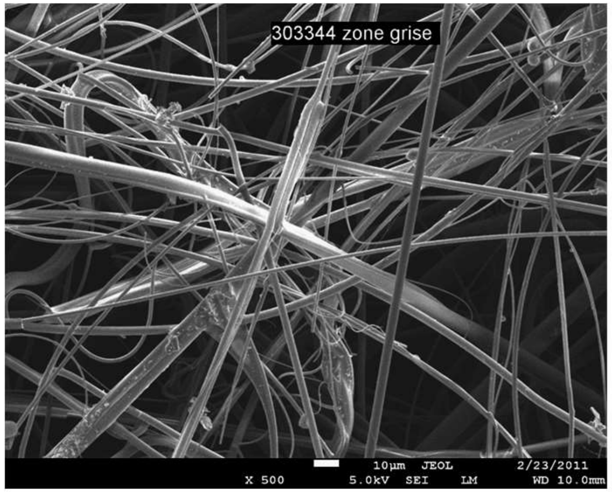




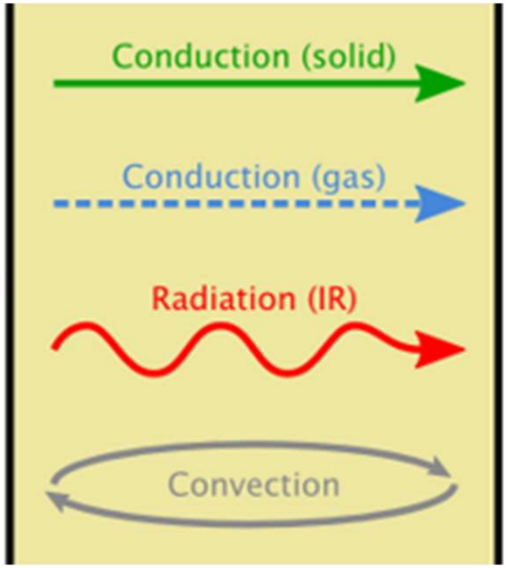
https://doi.org/10.1016/j.enbuild.2020.110540

Faster / better in situ diagnosis?
Also for acoustics, humidity

Principle of thermal insulation: air (or gas) trapping



$\lambda \sim 30–35$ **mW.m^{-1}.K^{-1}**

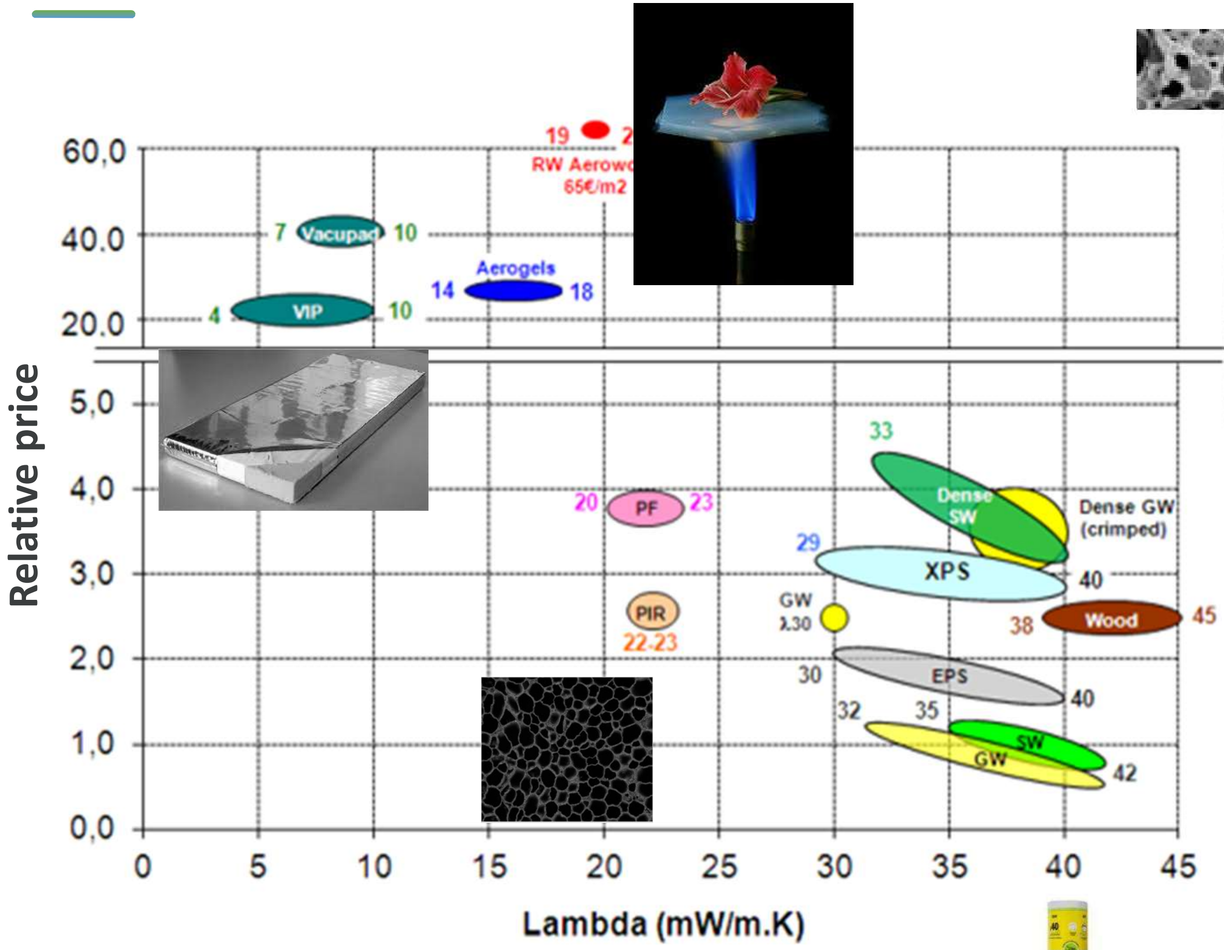


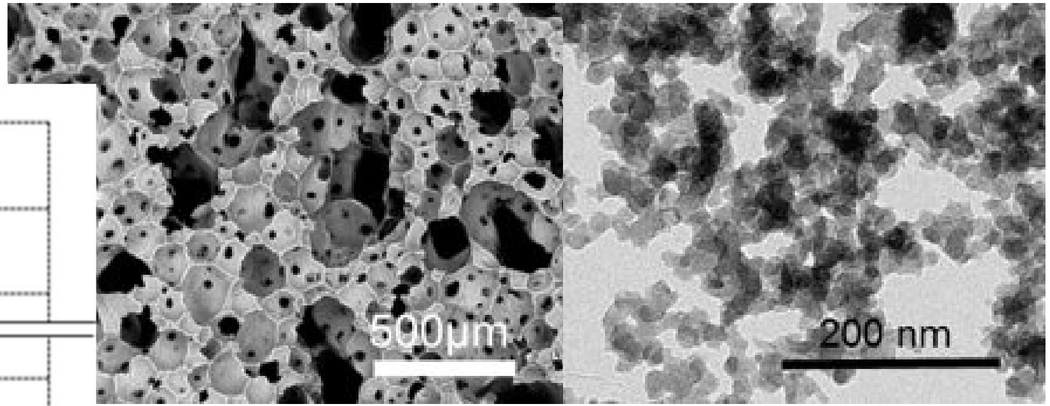
λ [mW.m^{-1}.K^{-1}] at 10°C

Silver	430 000
Aluminium	220 000
Steel	50 000
Ice	2 100
Water	600
Air	25
Argon	**17**
CO2	**16**
Pentane	**13**
CFC	**10**
Krypton	**9**
Xenon	**5**

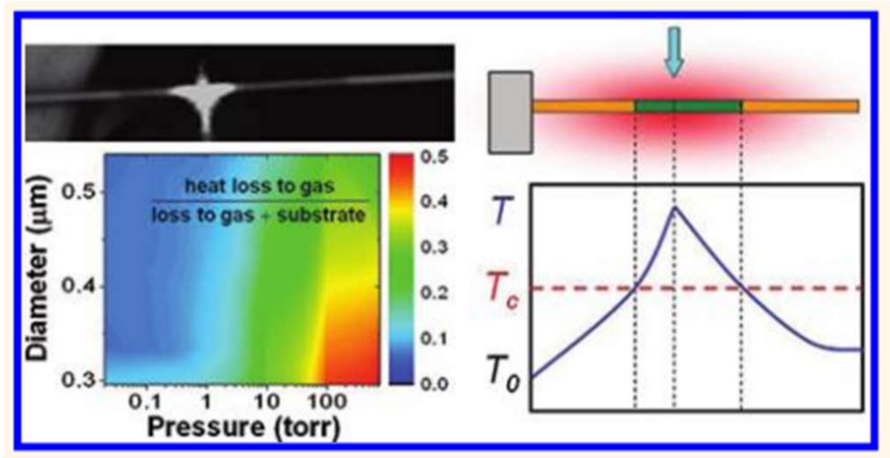
SAINT-GOBAIN

Super insulating materials at affordable cost?





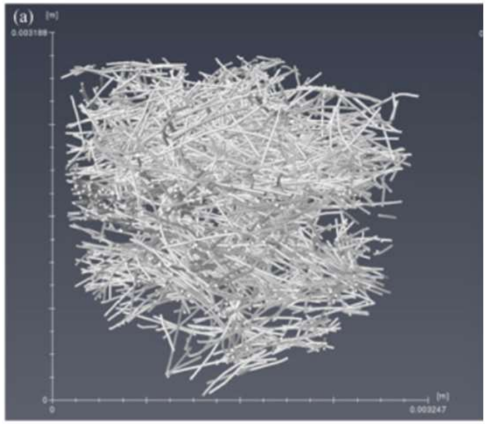
Coll. N. Denkov



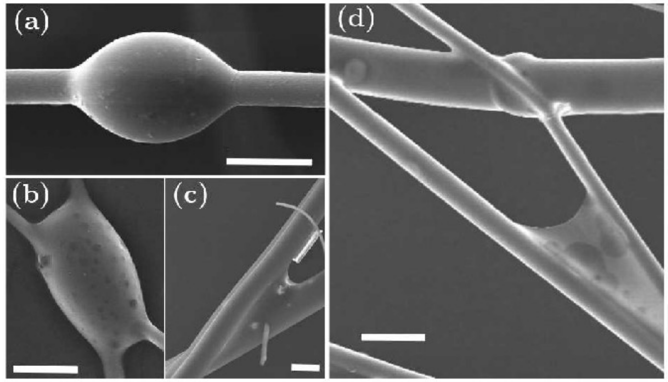
Cheng et al., ACS Nano 2011
https://doi.org/10.1021/nn204072n

SAINT-GOBAIN

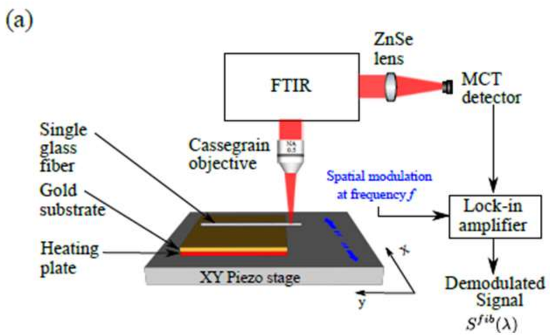
How to describe multiscale materials?



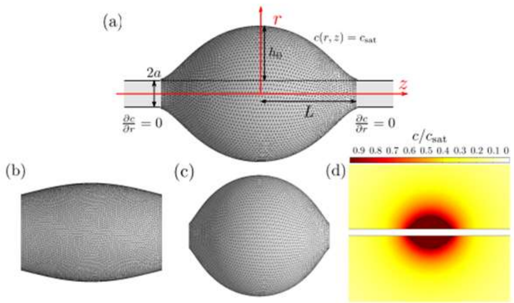
Meftah et al. Mat. Char. 2019



Sauret et al. EPJE 2015



Kallel et al. 2019
https://doi.org/10.1016/j.jqsrt.2019.106598



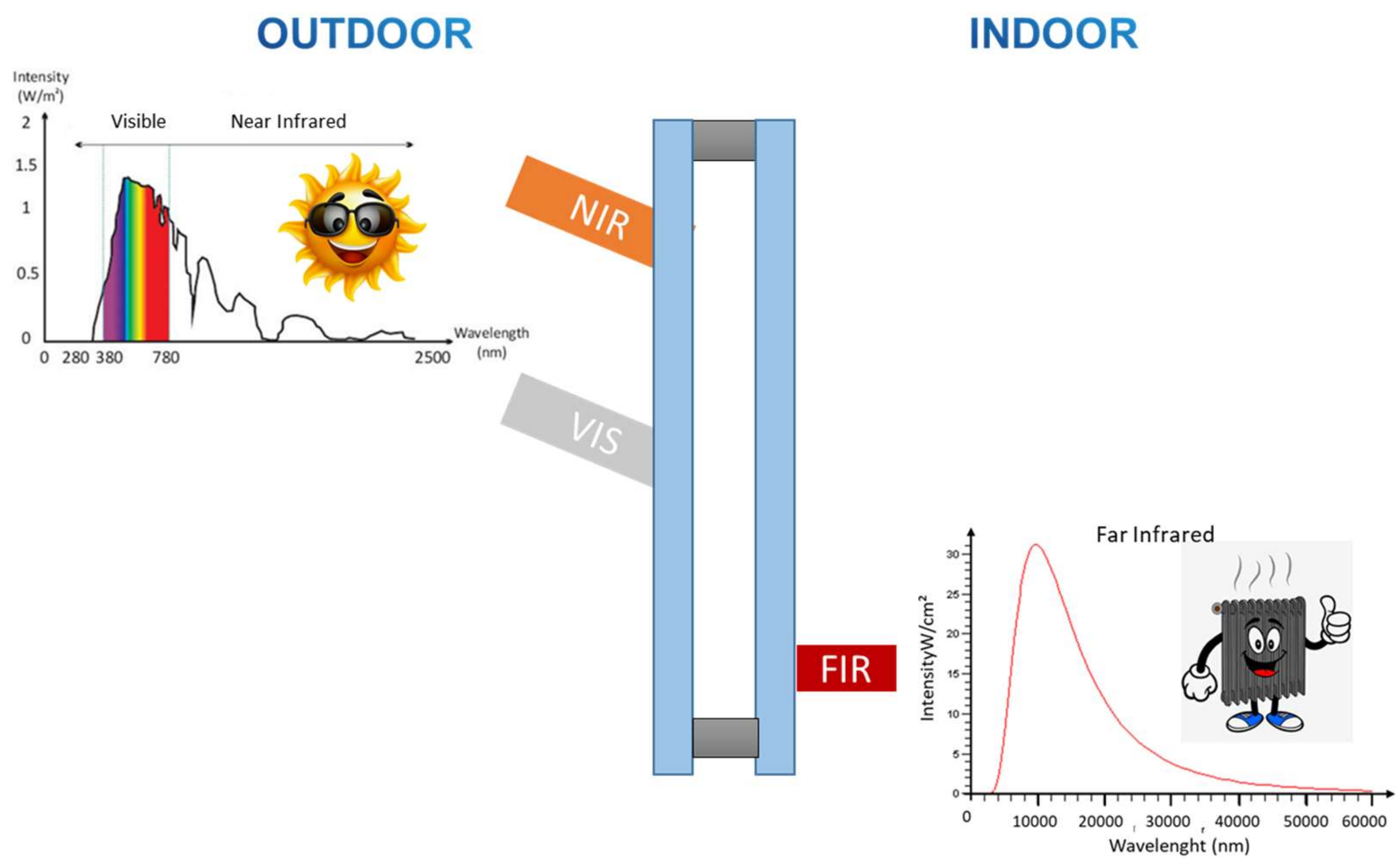
Corpart et al. EPL 2022

Thermal transfers, acoustics, mechanics
Link with microstructure and process

SAINT-GOBAIN

THIN FILMS FOR THERMAL INSULATION

Radiative exchanged through glazing

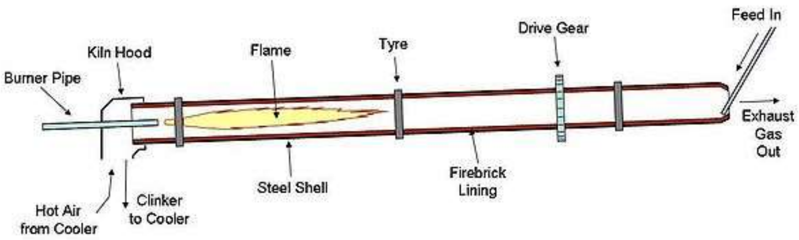


SAINT-GOBAIN

ACTIVE GLAZINGS: HOW TO ACHIEVE MODULARITY?

Decarbonizing products

High-temperature processes



0.9 kg CO2 / kg cement

1.8 kg CO2 / kg steel

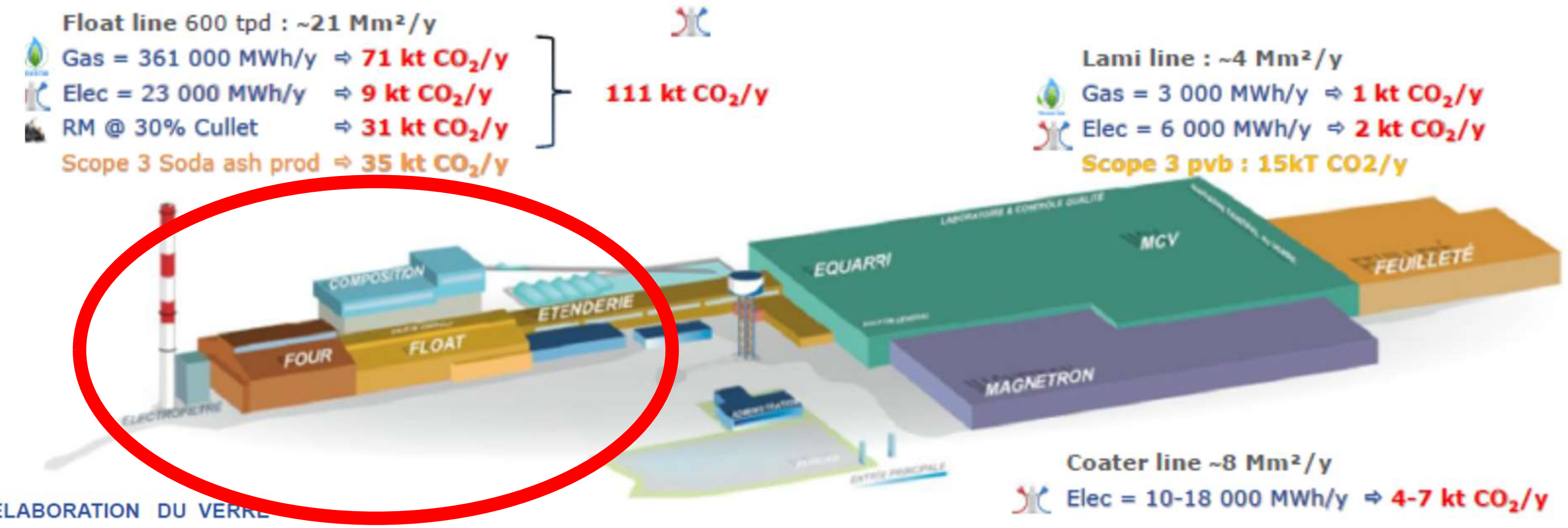
0.6 kg CO2 / kg glass

SAINT-GOBAIN

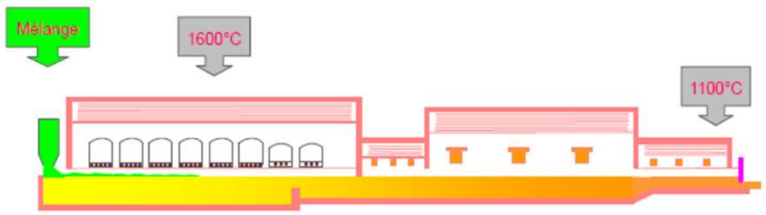
GLASS

FLOAT GLASS

FLAT GLASS PLANT 2020 OVERVIEW: ENERGY & RM CO_2 IMPACT TODAY (SCOPE 1, 2 & 3)

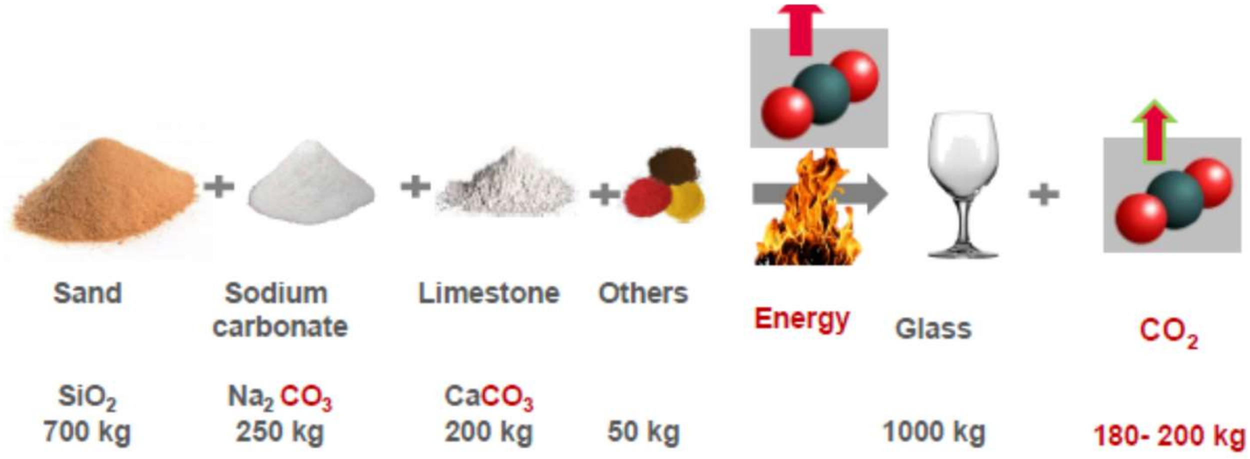


LE FOUR : ELABORATION DU VERRE



Ä 2000 Tonnes de verre en fusion

Ä Une tirée pouvant atteindre 750 t/j



Silica (SiO_2) + Carbonates + ε → Silicate + CO_2

Chemical Reaction : corrosion of the sand grains / melted carbonates

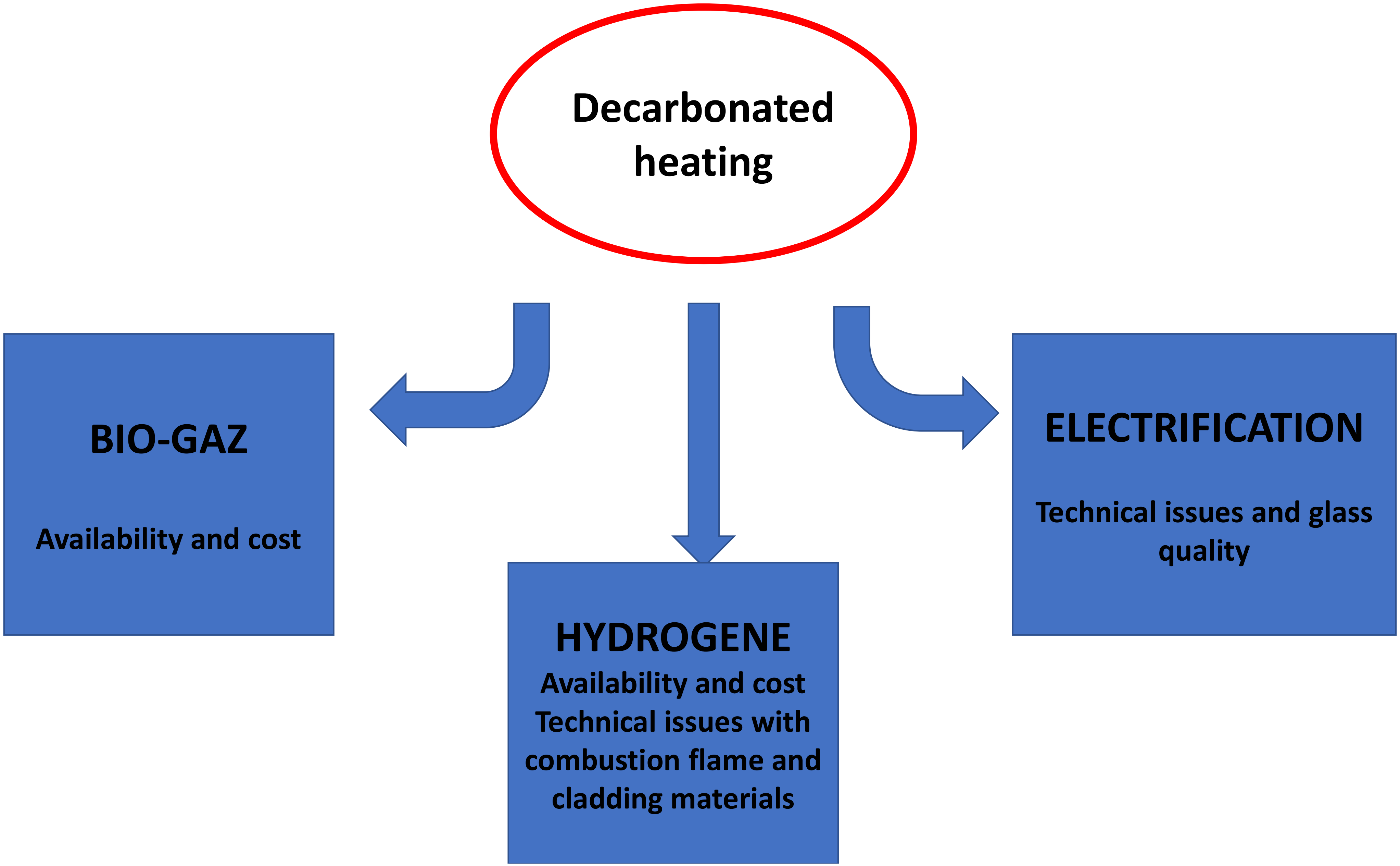
70 % Sand + Carbonates → silicate + CO_2

1700°C 800-900°C

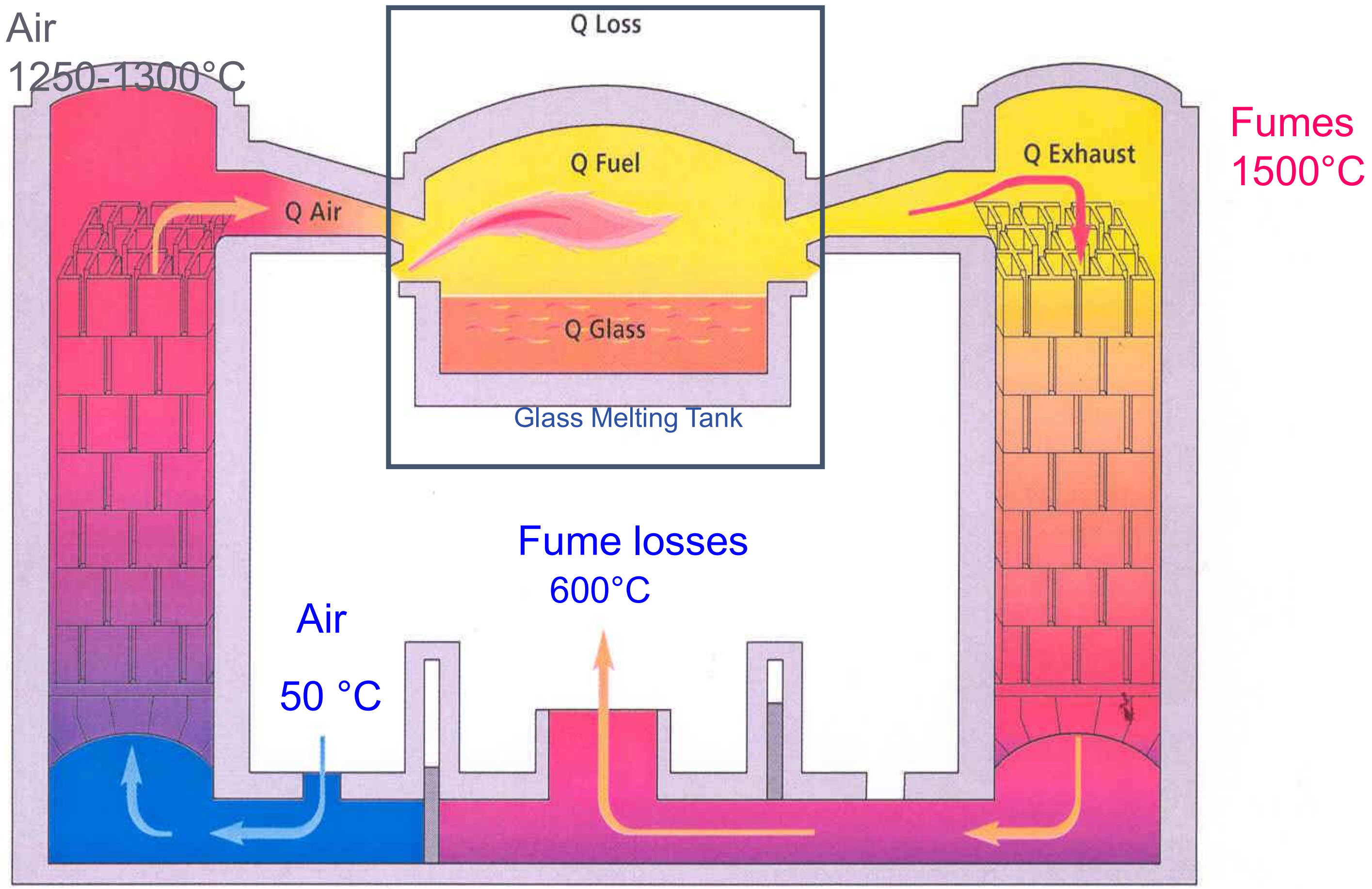
Can we replace carbonates?

Can we heat in a decarbonated manner ?

Can we use recycled glass?

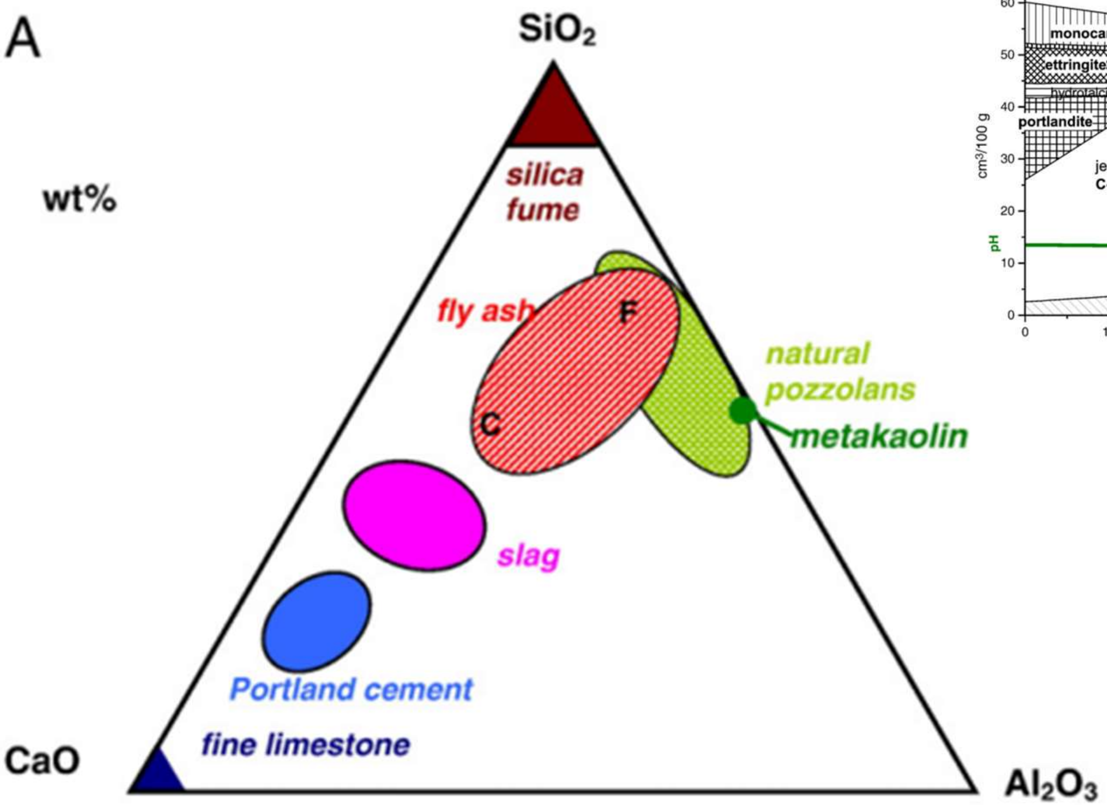

Decarbonated heating
BIO-GAZ
Availability and cost
HYDROGENE
Availability and cost
Technical issues with combustion flame and cladding materials
ELECTRIFICATION
Technical issues and glass quality

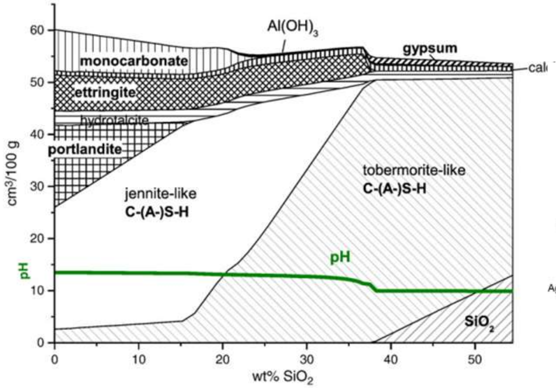
Minimizing waste heat

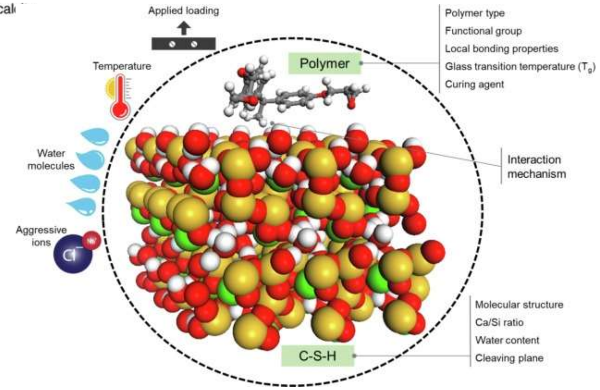


SAINT-GOBAIN

Alternative raw materials





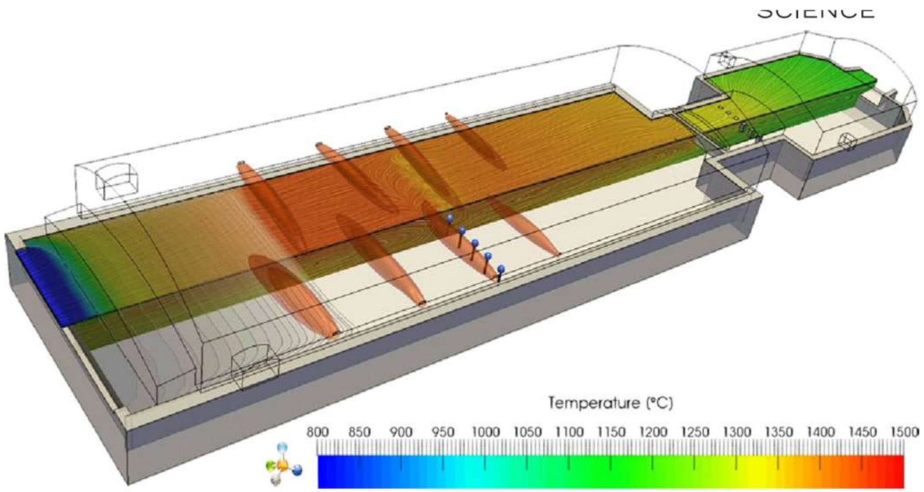


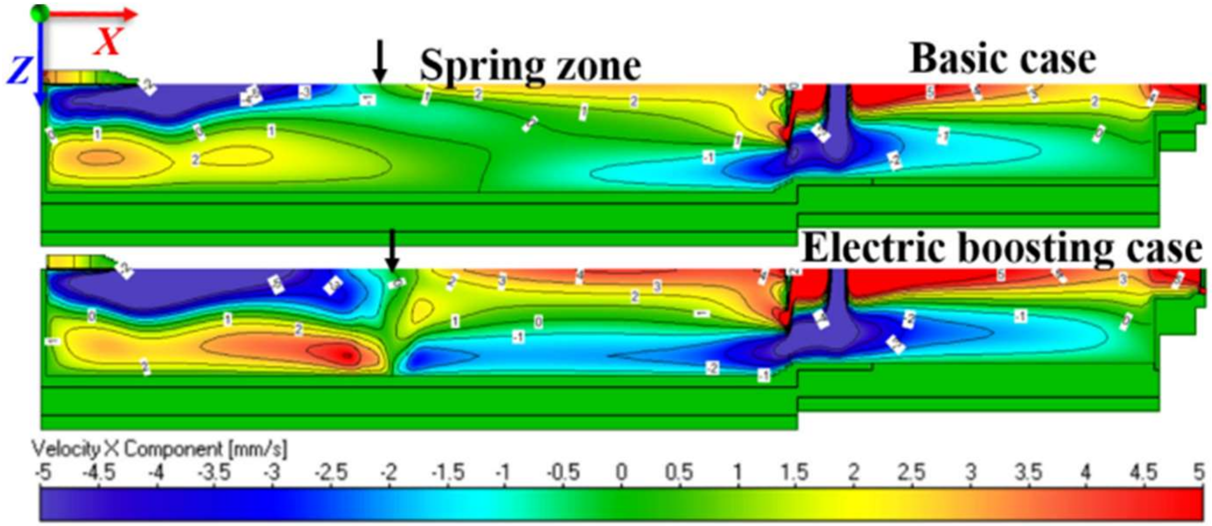
Thermodynamics,
Atomistic simulations,
Materials informatics,
Characterization

https://doi.org/10.1016/j.cemconres.2010.12.001 Lothenbach 2011

SAINT-GOBAIN

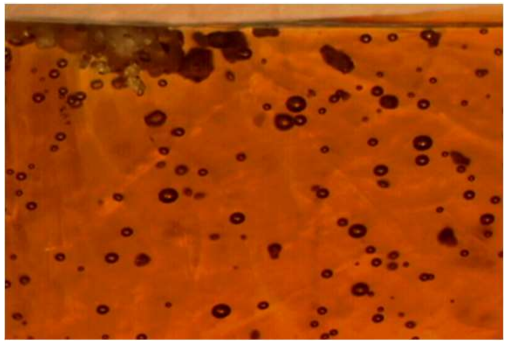
Float glass furnaces: from gas to electricity





[10.2320/matertrans.M2019044](https://doi.org/10.2320/matertrans.M2019044)

10.1111/ijag.12286



Multiphysics: combustion, fluid mechanics, chemical reactions, …

Multiscale: bubble size to furnace size

How to accelerate simulations ?

How to make accurate predictions from approximate models?

Electrification of processes

EVOLUTION VERS DES FOURS BAS-CARBONE

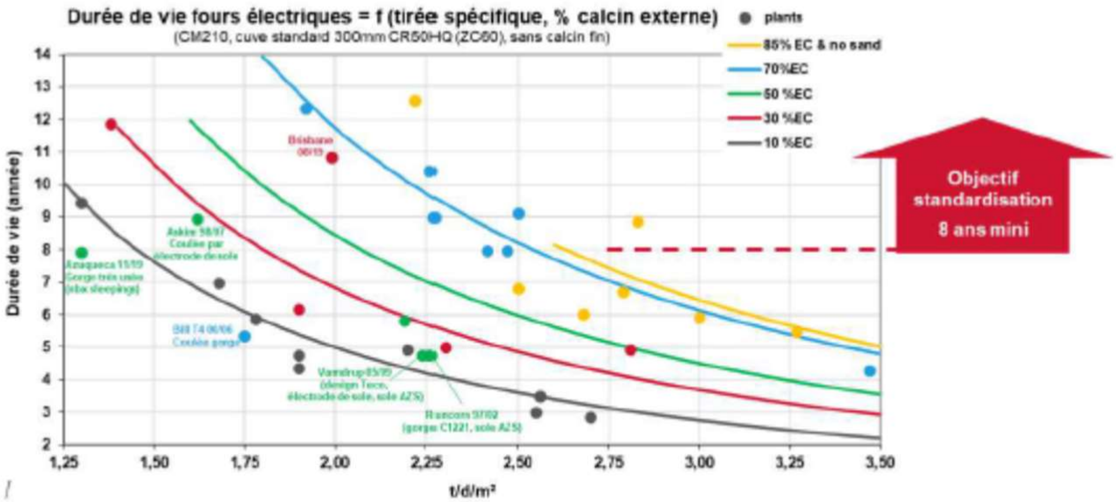
Fours électriques

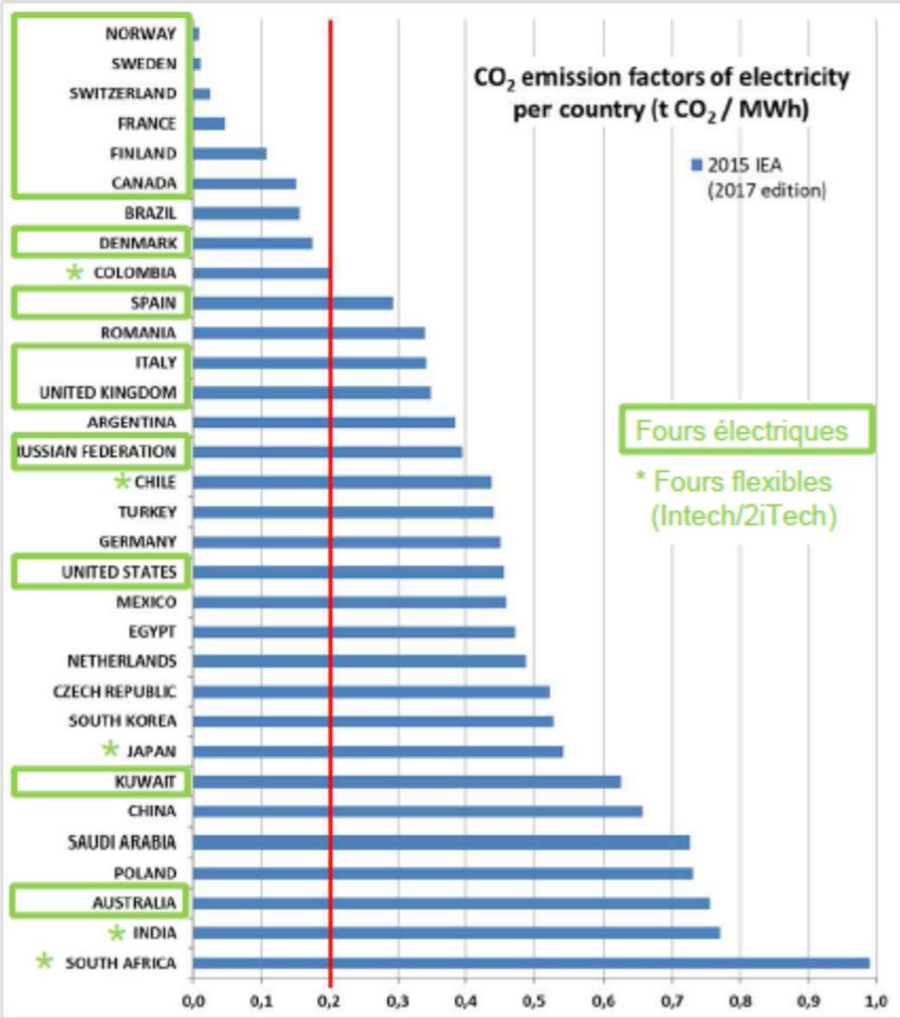
Nécessité d'une électricité verte

Emission résiduelle par la composition : hausse du calcin

Points majeurs

- A terme, 100% des fours à électrodes plongeantes (EHS)
- Duré de vie très sensible à la tirée spécifique et au %calcin



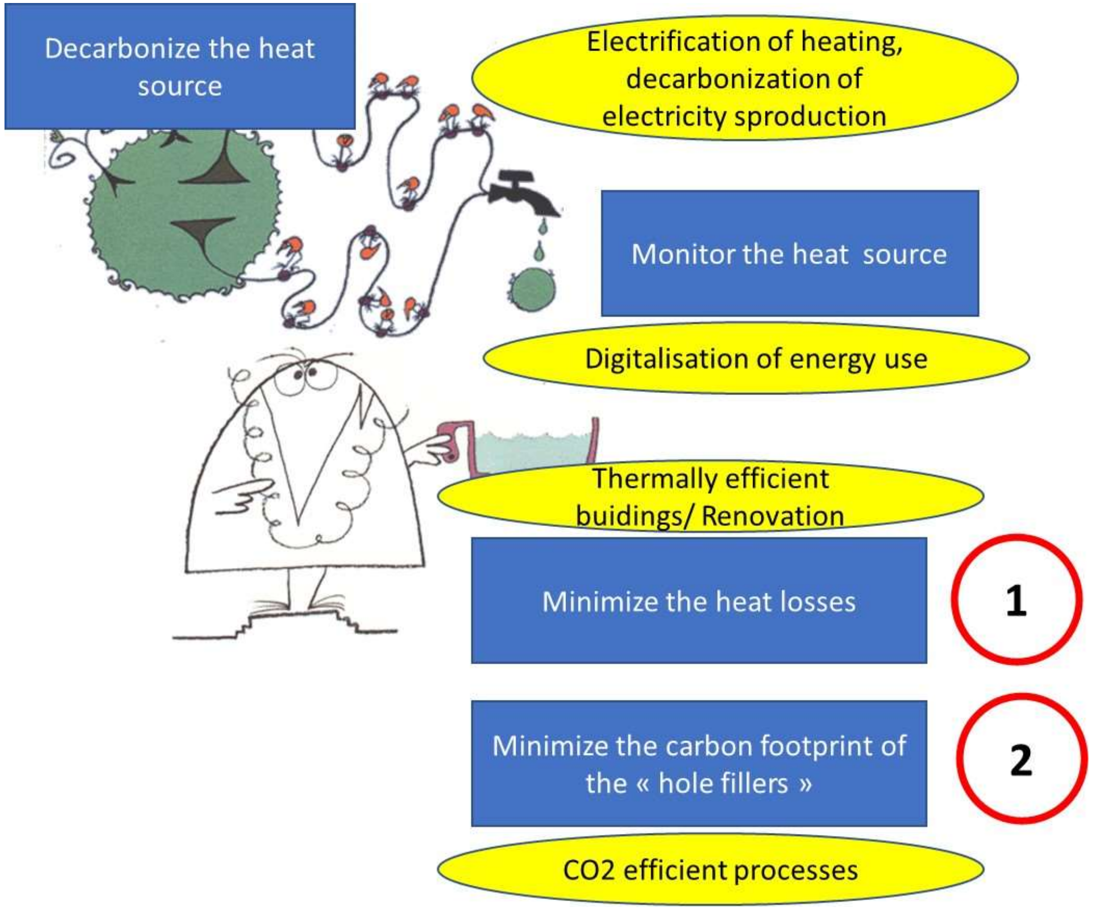


CAVEAT!!!

- Glass furnaces are Continuous processes h24
- Power breakdown is a major threat

  => Above a few hours, heating via a safety burner is no longer efficient
- Emergency provision lines will be a problem: availability? Dimensioning?
- Electrification may makes sense if
  - Electricity is decarbonated
  - Electricity provision is stable

Conclusions



- **Thermal management of buildings is a major contributor to economy decarbonation**

- **No matter the way one produces energy , or the cleverness with which it is used , a prerequisite is NOT TO WASTE IT**

- **Building thermal management efficiency is possible with technologies already available, and always progressing, which can be produced by national industry. Contribution to Reindustrialisation**

- **The emphasis should be on renovation**

- **production of glass, plaster, insulation materials, can be at least partially electrified and decarbonized in the coming years**

- **DECARBONISED AND STABLE ELECTRICITY IS A PREREQUISITE FOR INDUSTRIAL ELECTRIFICATION**