Environmental assessment of hydrogen vector applied to mobility

51th LCA discussion forum

THE ROLE OF ENVIRONMENTAL LIFE CYCLE THINKING IN LONG-TERM (ENERGY) STRATEGIES

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Outlook

- Goal and scope
    - partners involved
    - context and objectives
    - scenarios assessed and functional unit
- Literature review and first LCA results
- On the way to transition LCA

Study goal and scope

Who is involved ?

- Client
- Consultancy agencies
- Steering comity
- Critical review panel

Context - why H2 in mobility ?

Taking advantage of electrical mobility

Without fumes

No noise motor

Smooth driving

While benefiting from hydrogene

Long running life

until 600 km

High speed charging

Security : no electricity storage

Why doing this study ?

- Building life cycle thinking awareness and mobilising the H_2 sector

- Contribute to guide public funding decisions on H_2 production and use options in mobility

Study objectives

- Identify most impacting life cycle stages of 4 different options for H_2 use in mobility
- Compare those options

For illustration purpose : comparison with non H_2 mobility options

- *thermal engine vehicle*
- *electricity vehicle*

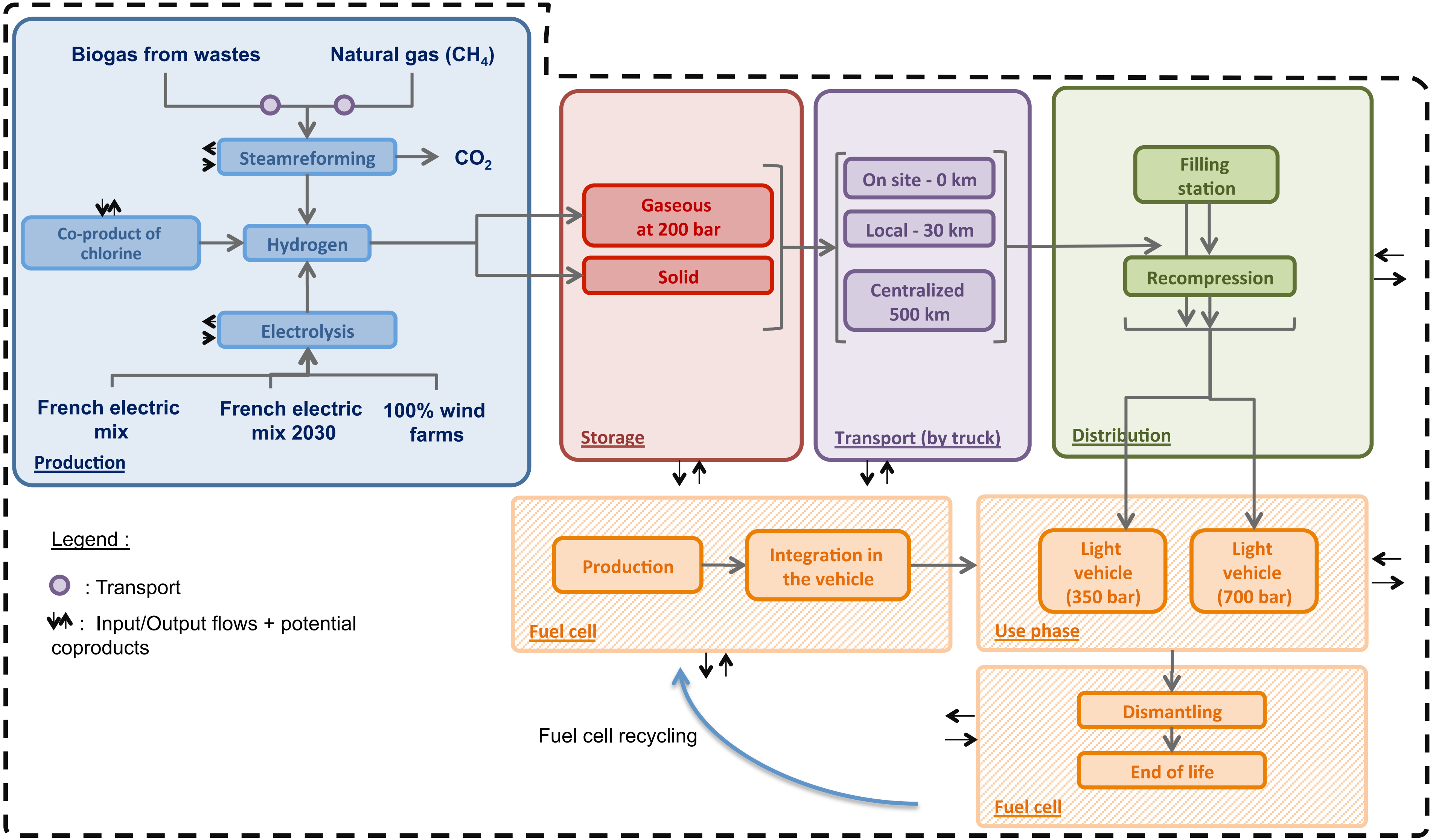
Functional units

- Full life cycle
  - One kilometer transport by the vehicle

passenger car vehicle type Golf A4, transport cycle NDEC

- Cradle to gate
  - one kg of H_2 at the factory gate at 30 Bar

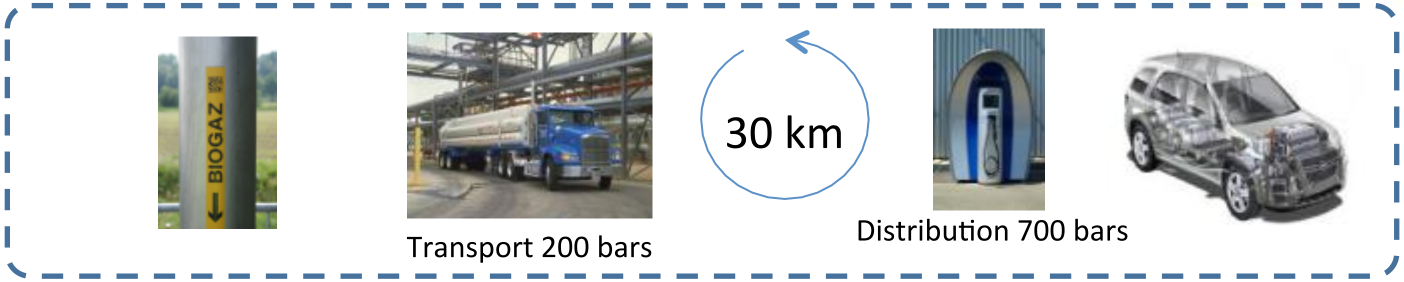
System boundaries



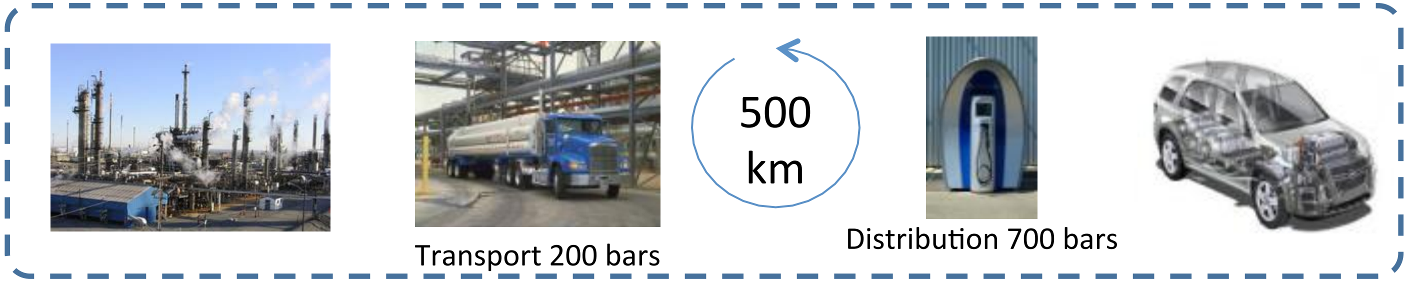
Four scenarios selected detailed analysis, excel calculator to assess all combinations

Four selected scenarios

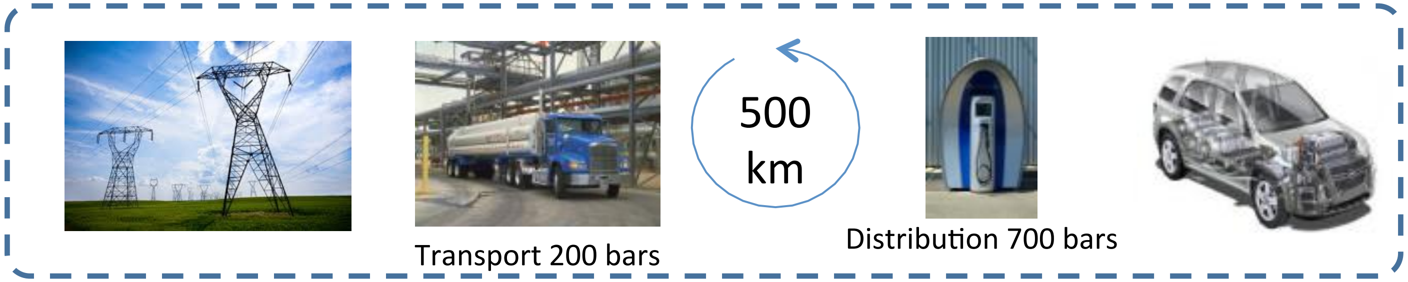
Scenario 1 : local production biogas steam reforming



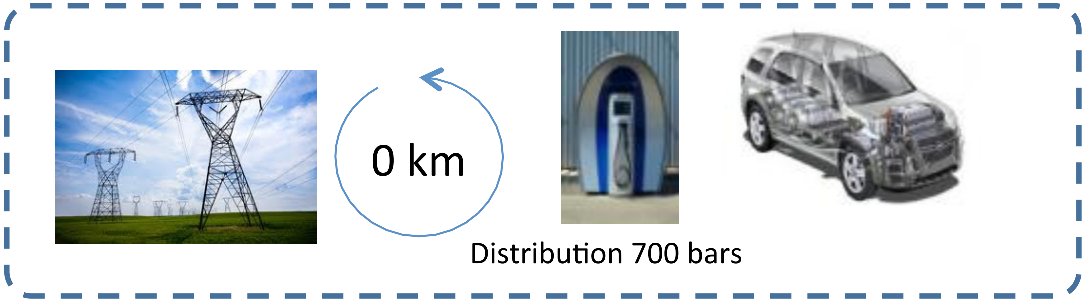
Scenario 2 : centralized production from natural gas steam reforming



Scenario 3 : centralized production from electrolysis from mix FR



Scenario 4 : production from electrolysis on site from mix FR 2030



Impact assessment method : ILCD

Impact category
Climate change
Ozone depletion
Human toxicity, cancer effects
Human toxicity, non-cancer effects
Particulate matter
Ionising radiation, human health
Ionising radiation, ecosystems
Photochemical ozone formation
Acidification
Terrestrial eutrophication
Freshwater eutrophication
Marine eutrophication
Freshwater ecotoxicity
Land use
Water resource depletion
Minerals, fossils and renewable resource depletion

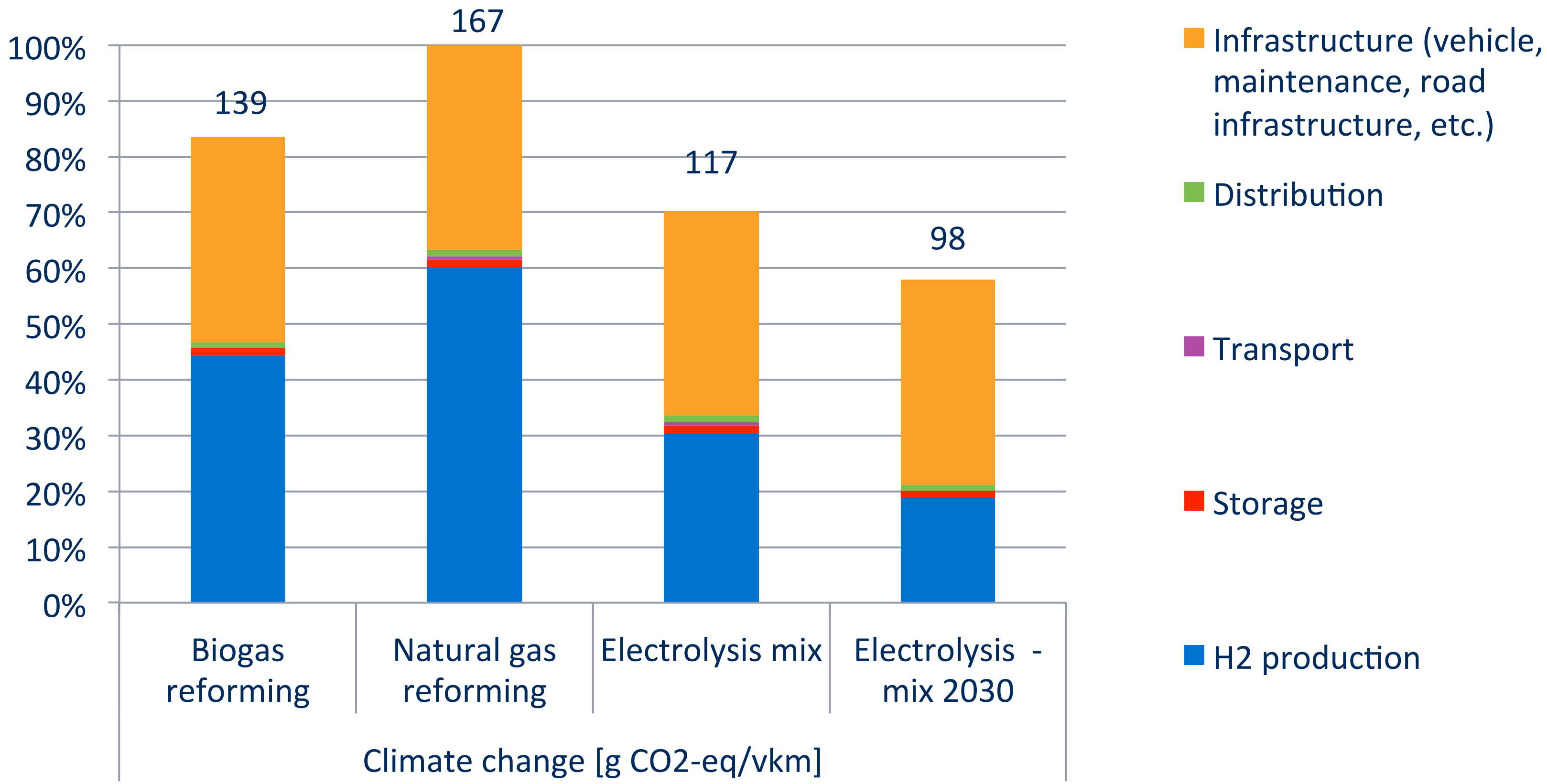
Main data sources

- Electric mix 2030 : ADEME 2012
- H_2 production : Felder 2007
- Vehicle and fuel cell : Felder 2007 and adaptation of ecoinvent 2.2
- Other data and background data : ecoinvent 2.2

to be adapted with primary data from manufacturers

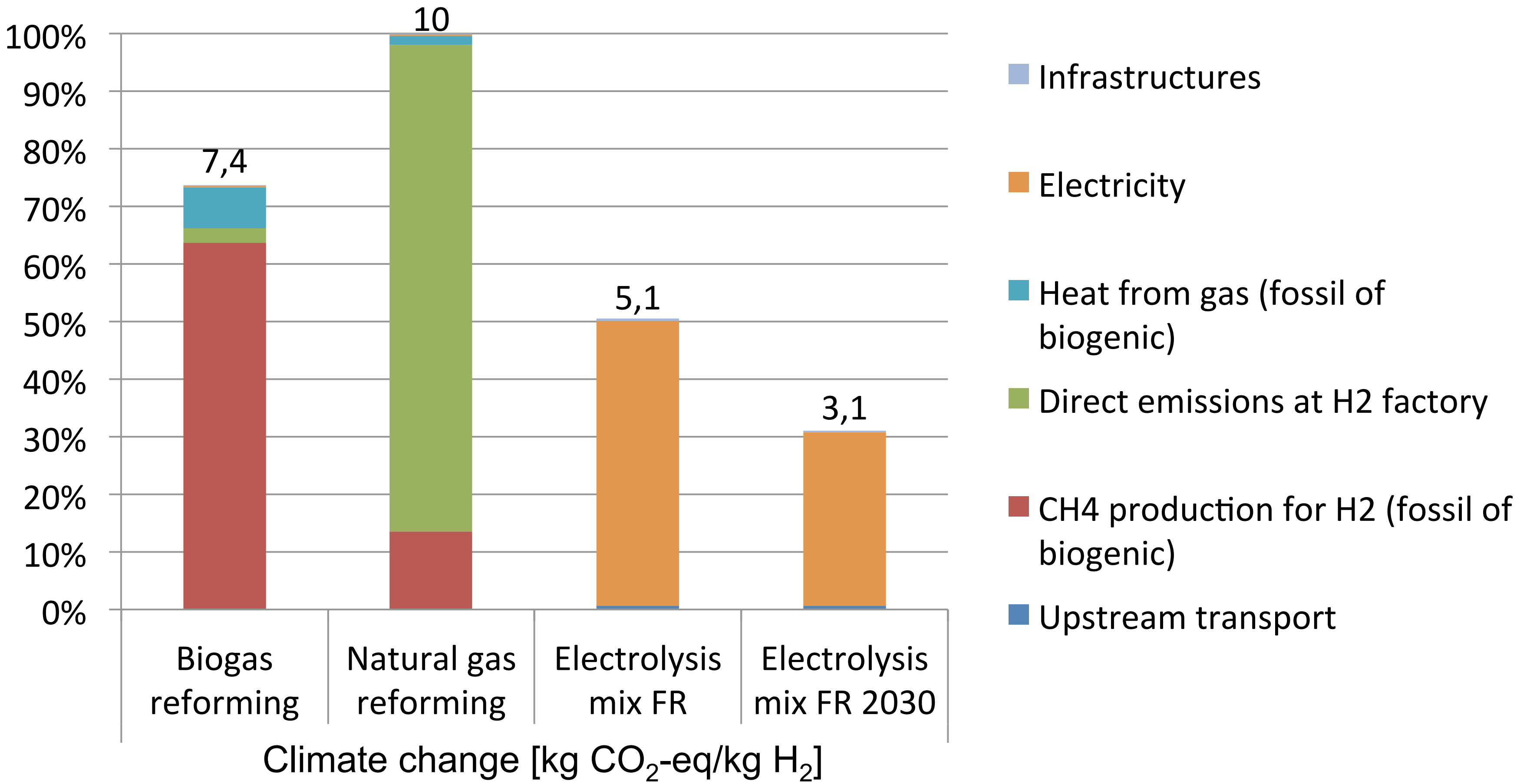
Literature review and first results

Climate change impact – full life cycle



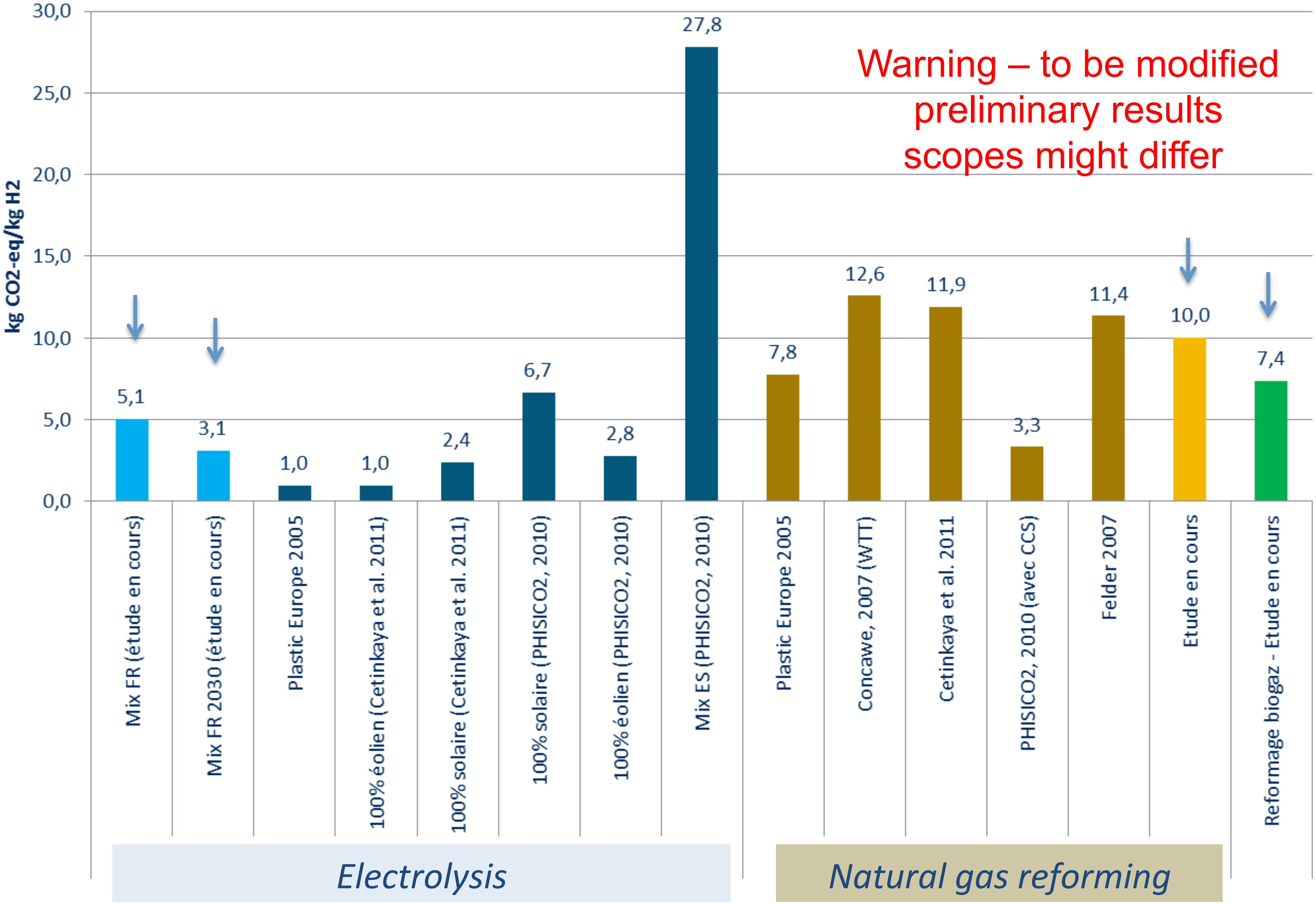
Warning – to be modified - preliminary results

Climate change - H_2 production cradle to gate

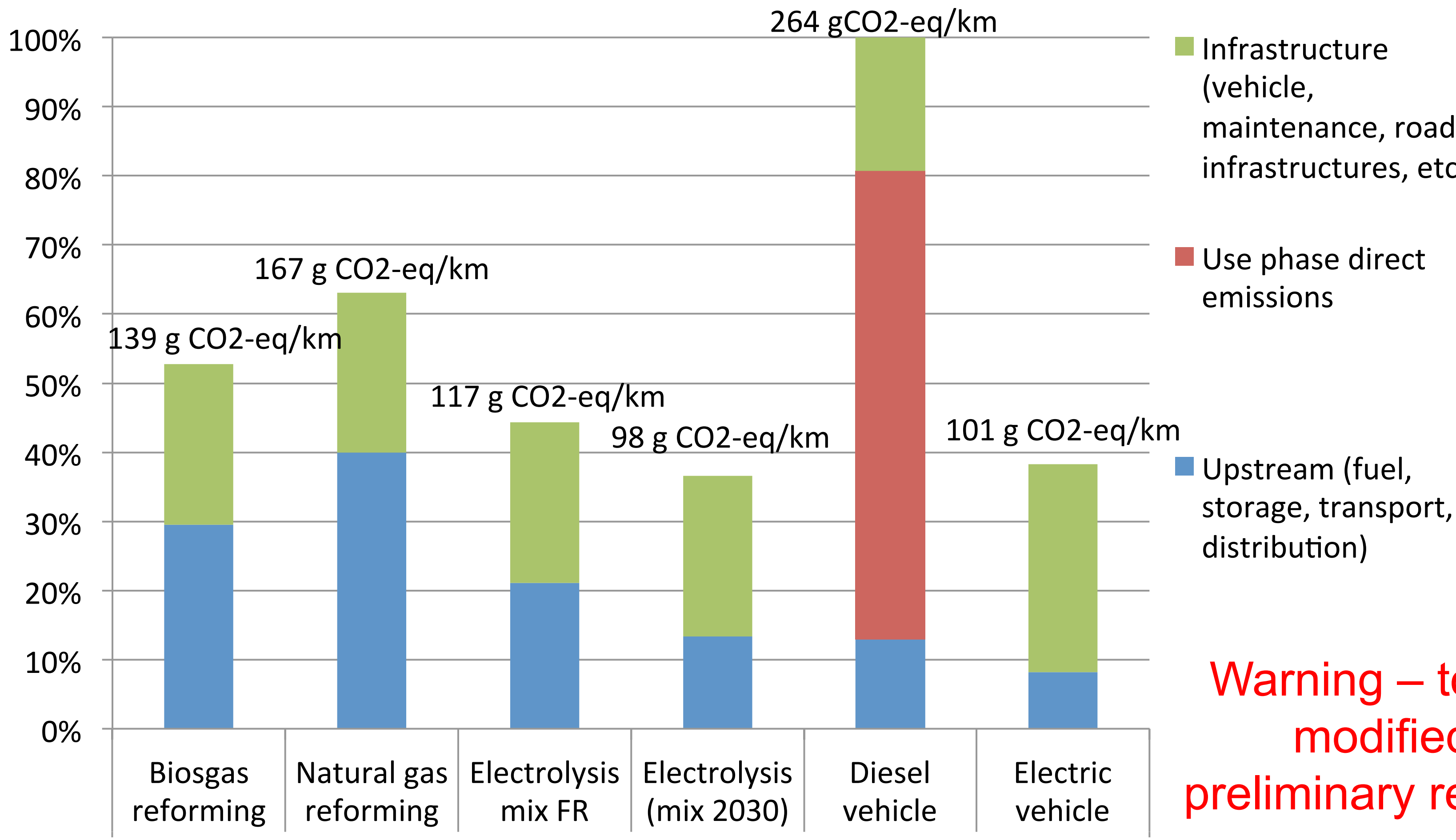


Warning – to be modified - preliminary results

Climate change - literatture review – H2 production



Climate change impact – full life cycle



Warning – to be modified preliminary results

Intermediary conclusions and next steps

- Main impacting stages for climate change :
  - H_2 production
  - Infrastructure (vehicle, road construction)
- Lowest climate change impact scenario : electrolysis with FR 2030 electricity mix
- Final results to be released in august 2013
- No scenario ranking homogeneity for the other impact categories
- Data to be refined especially on
  - infrastructure : vehicle production & material composition of the fuel cell
  - H_2 production from biogas reforming

→ primary data being collected from manufacturers

On the way to transition LCA

From attributional LCA to transition LCA

For a given time line

Environmental sustainability
- ✓ towards 100% renewable energy production
- ✓ limiting CO2 atmosphere concentration to 350ppm based on per capita emission quota
- ✓ sustainable land use
- ✓ …

$$global\_impacts = population \times \sum_{service} \left(N_{service} \times \frac{I_{service}}{FU_{service}} \right)$$

Transition LCA: $N_{service} \times \frac{I_{service}}{FU_{service}}$

Standard attributional LCA: $\frac{I_{service}}{FU_{service}}$

	Term of the equation	Unit	Definition	Example	Related concept
Inputs of the sustainable society scenarios	$\frac{I_{service}}{FU_{service}}$	[Impact] / [FU]	Impacts of the service per Functional Unit	Impacts (climate change, resource consumption, etc.) per km of transport by car	Environmental efficiency
Outputs of the sustainable society scenarios	$A_{service}$	[FU]	Total amount of the service used by the population	Total amount of kilometers for car transport	Environmental sobriety
	$N_{service} = \frac{A_{service}}{population}$	[FU]/person	Use intensity of the service per person	Average car transportation distance per person	Equity and human rights

Thank you for your attention !