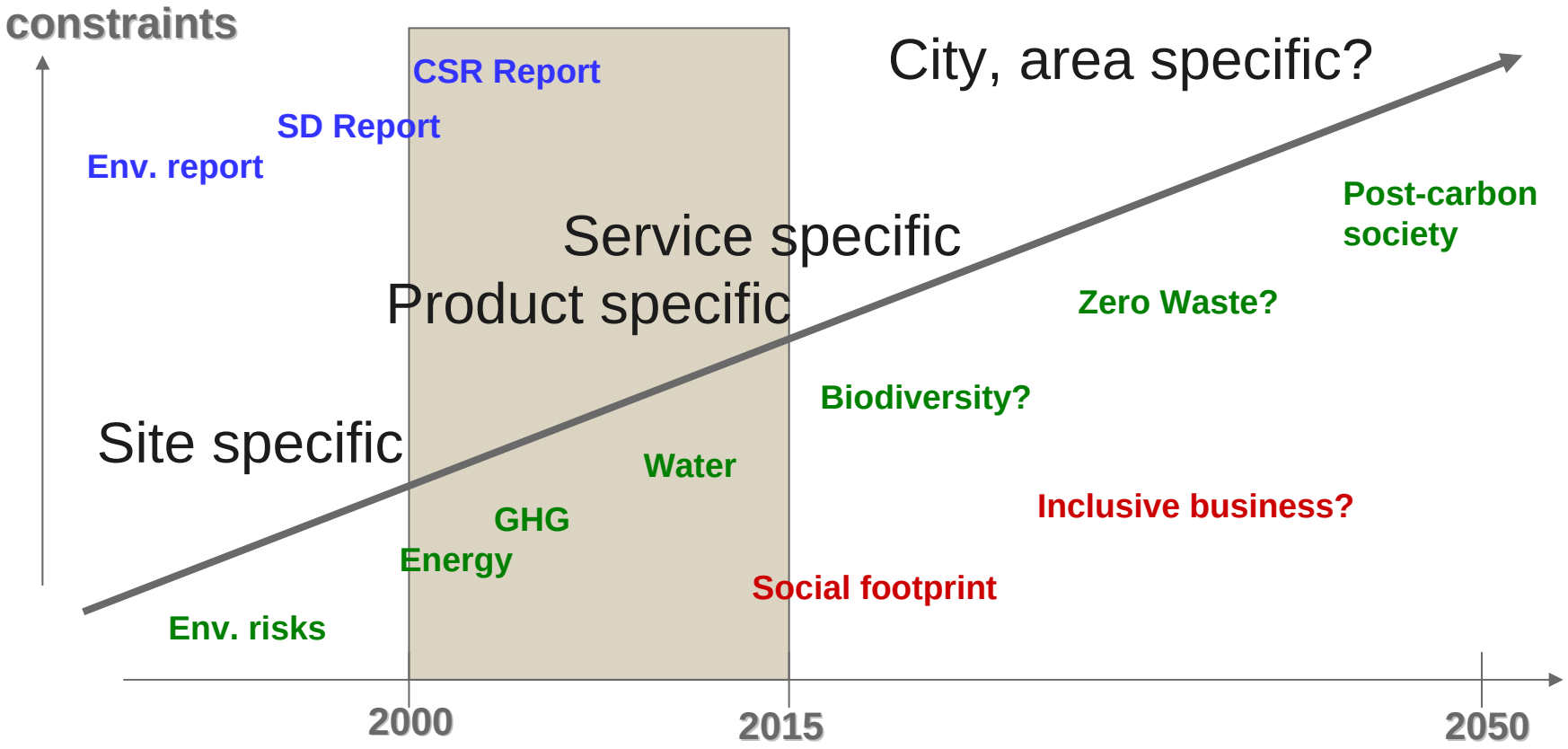
EU-US Frontiers of Engineering Symposium

Steel, a sustainable material

JS Thomas, ArcelorMittal Global R&D

- **Context and challenges of Sustainable Development**
- **Steel, a sustainable material?**
- **How to capture sustainability? Methodology issues**
- **The Sovamat Initiative: toward a sustainability metrics**

Sustainable Development: Context and Challenge



1. **Measure!!**
2. **Pro-actively anticipate and adapt offer and performance to legislation evolution and customers needs**

- Context and challenges of Sustainable Development
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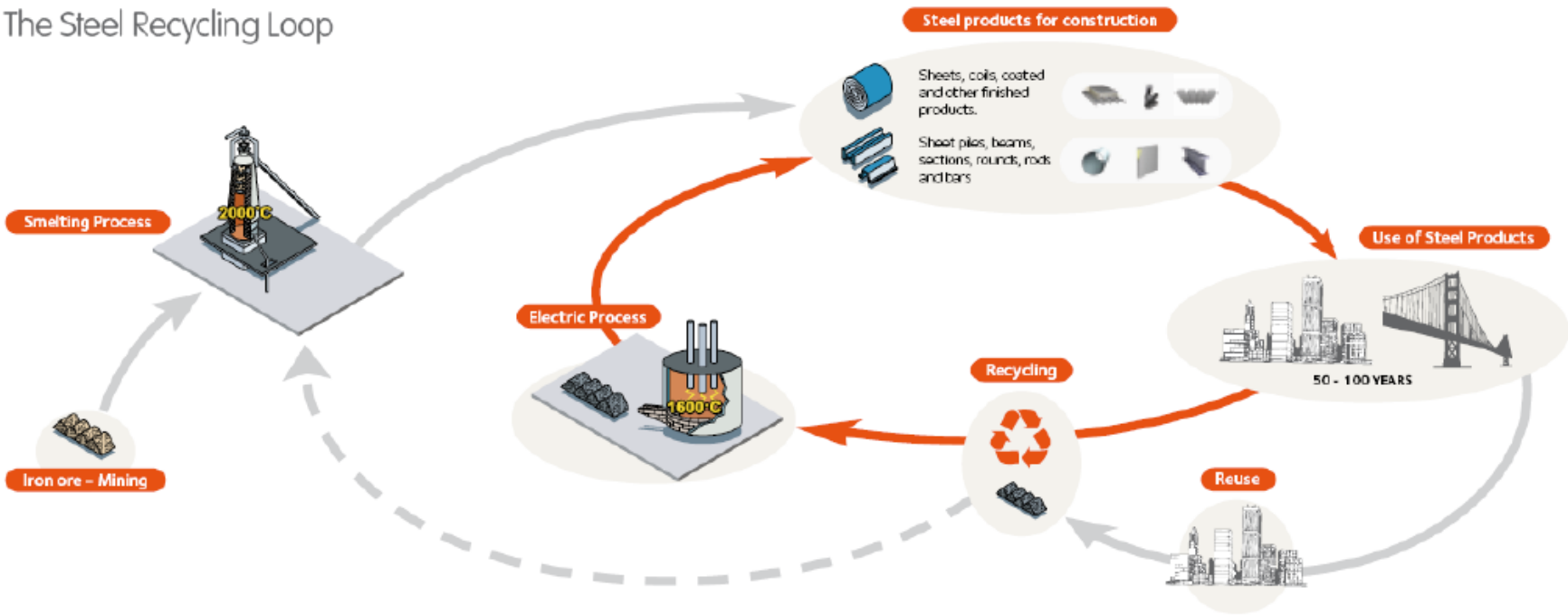
Steel production

- Two main routes for one product: steel
  - BF/BOF route (mainly primary)
  - EAF route (mainly secondary)

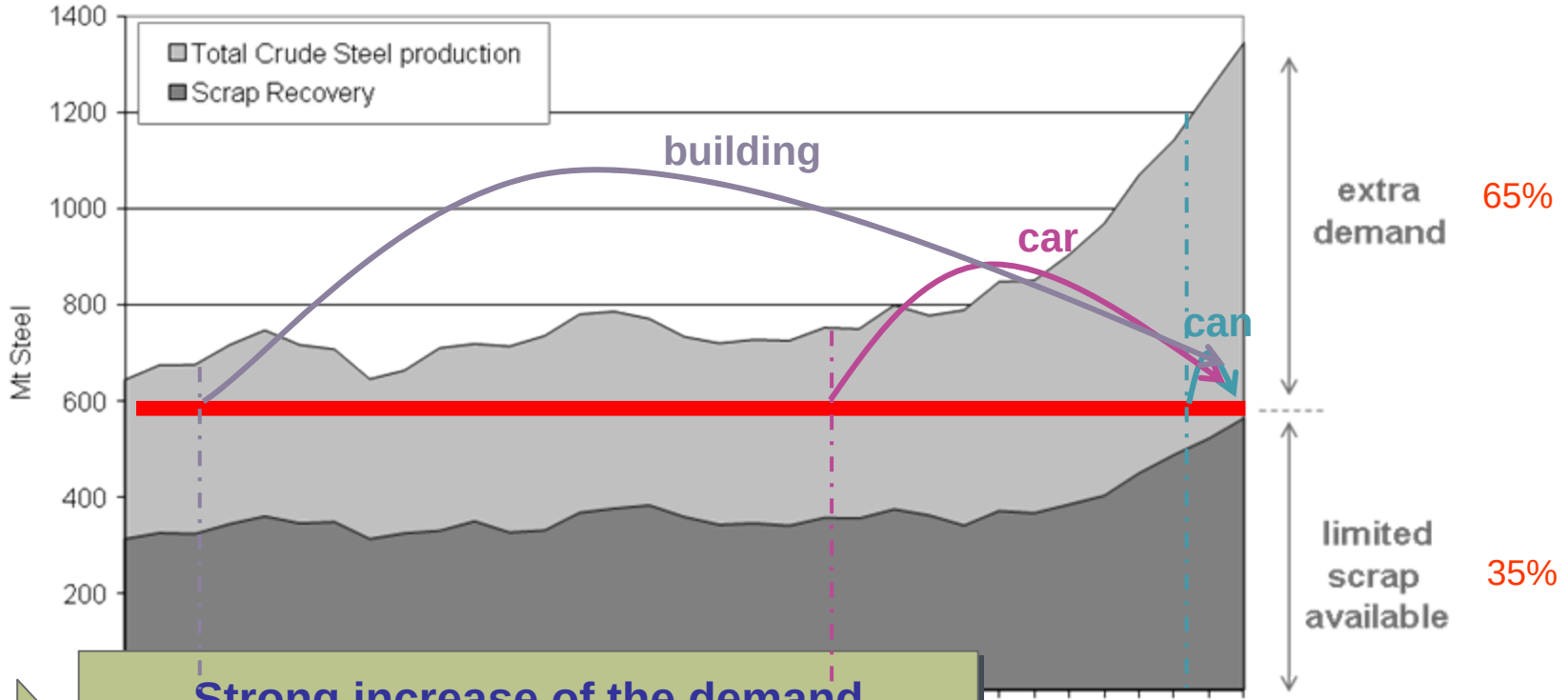


2 routes = 1 product

Demand steel vs. scrap offer

- **Increase of steel demand**
- **Lack of available scrap**

- **Percentage of primary production still high**



Strong increase of the demand
Recycled content limited

Steel cycles

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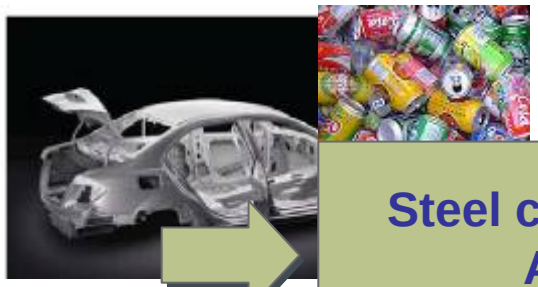
Recycled content (RC)

- Steel Overall Recycling Rate ~ 90%

Sector	Market size	Overall RR
Packaging	5.5%	66%
Automotive	30.2%	99%
Domestic Appliances	5.0%	93%
Construction	43.6%	85%
Machinery	15.7%	91%

Steel Overall Recycling Rates
based upon North American data (Steel Recycling Institute 2005)

End of life
Recycling Rate (RR)



Steel can be indefinitely recycled in ANY type of application

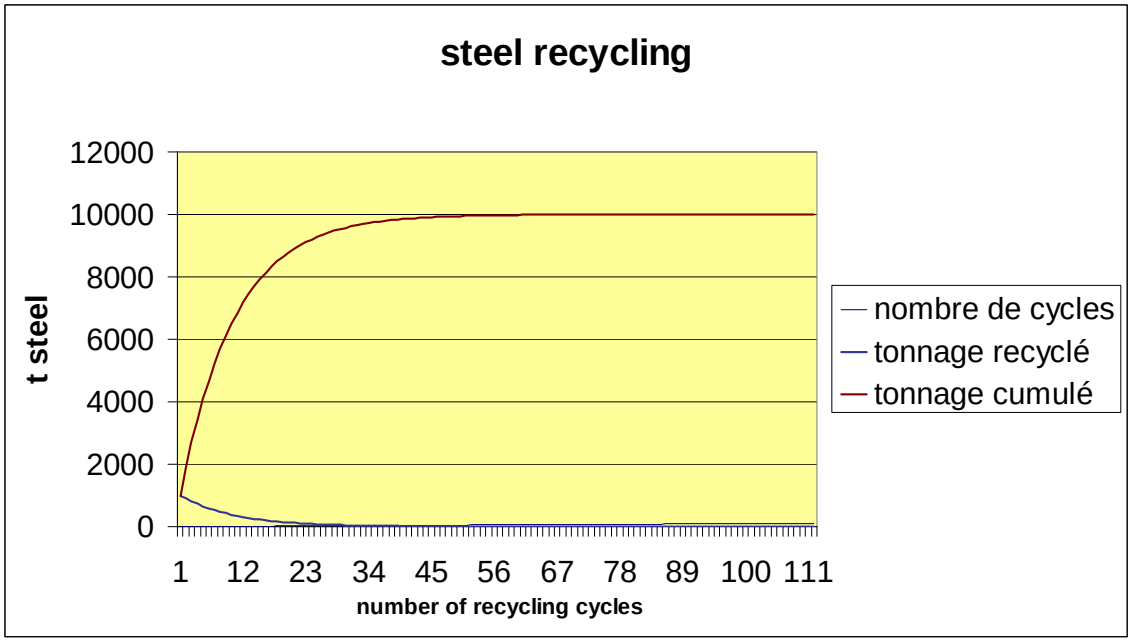
Steel recycling benefits

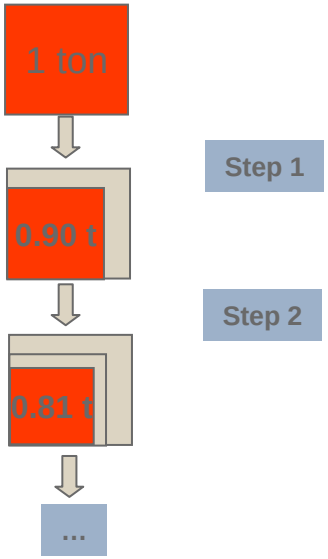
n number of cycle

$$Tcum = Tini \times \frac{(1 - R^{n+1})}{1 - R}$$

n infinite

$$Tcum = \frac{Tini}{1 - R}$$



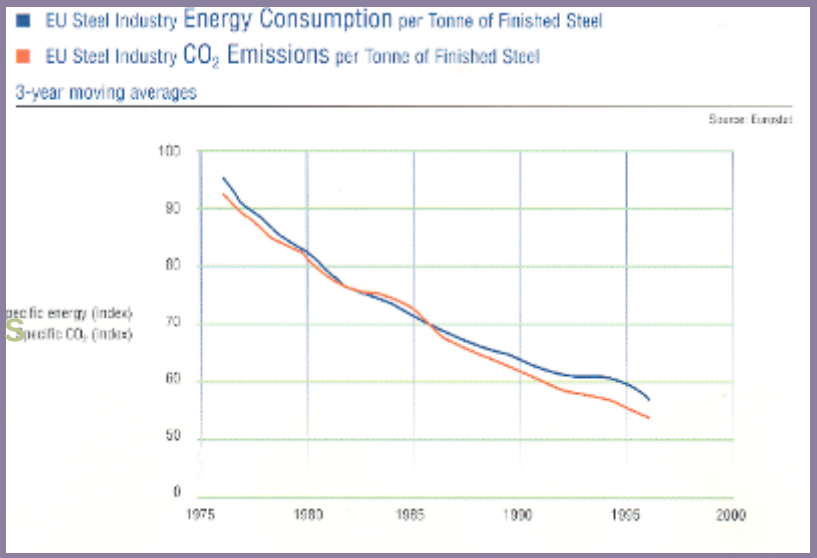


Recycling rate : 90%

For a 90% recycling rate:
1 ton of primary steel = 10 tons of steel used!

Sustainable stock of iron for future generations

Steel is constantly reinventing itself …



77 Hudson at Colgate Center, Jersey City

Colonnes S355

↓

Colonnes S460

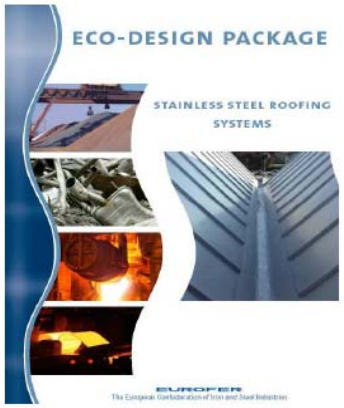
Weight savings:

17%

Ultra Low CO2- steelmaking

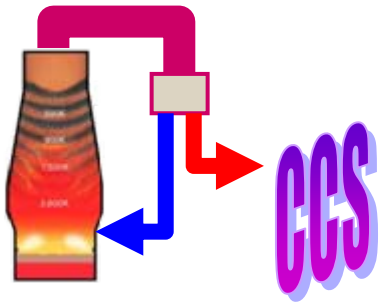
ULCOS is the most ambitious program in the steel industry level worldwide to face the climate change issue at a radical

- **Objective**: develop breakthrough steel production routes to reduce specific CO2 emissions by a factor 2 (or more)
- Launched in 2002
- 75 M€ spent to date



ULCOS: Ultra Low CO_2- steelmaking

- After screening: 4 routes selected for further development

Coal & sustainable biomass		Natural gas	Electricity
Revamping BF	Brownfield	Revamping DR	Greenfield
TGR-BF 	HIsarna 	ULCORED 	ULCOWIN ULCOLYSIS 
Pilot tests (1.5 t/h) Demo phase under preparation	Pilot plant (8 t/h) start-up 2010	Pilot plant (1 t/h) to be erected in 2010 ?	Laboratory

Focus on TGR-BF

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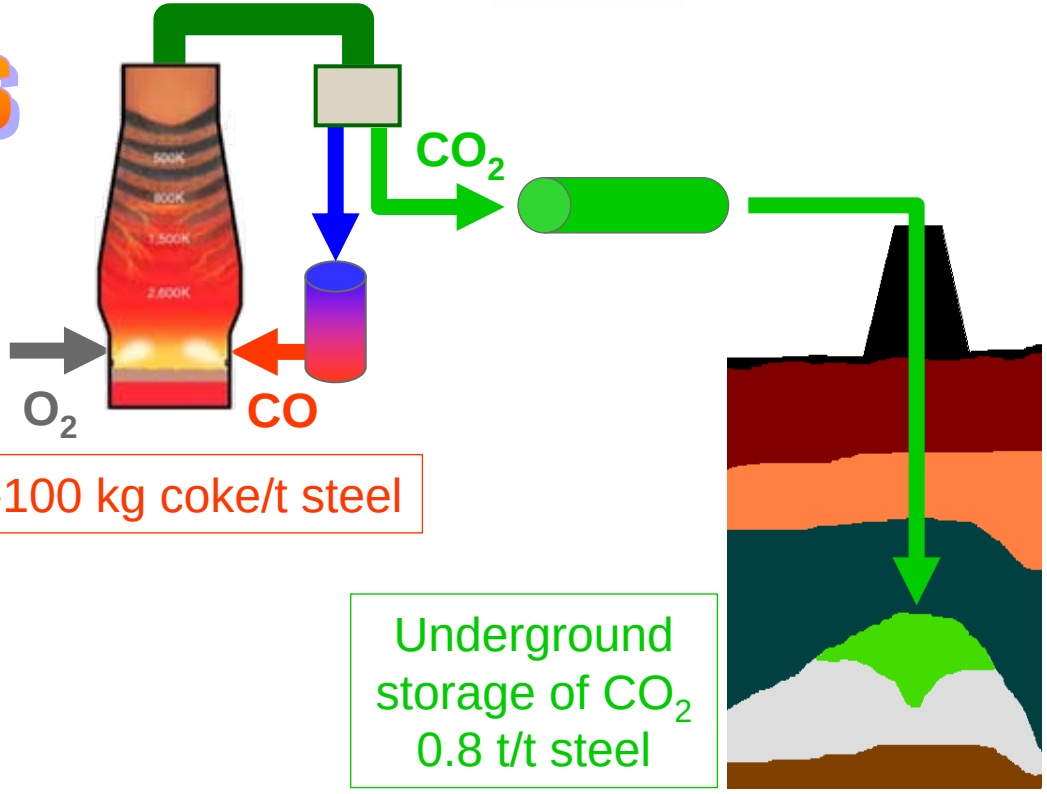
Using a single capture unit !!

CO_2 emissions of the steel plant: **- 60%**

Principles



-100 kg coke/t steel

Underground storage of CO_2 0.8 t/t steel

Social and economical benefits

Example of a steel bridge

- Aestetic: Light structures
  - Less materials, reduced foundations → reduced cost
- Perennity of the material
  - Resist to earthquakes → safety
  - Reduce maintenance, visible pathology, forecast inspections → reduced cost, safety
- Dry workplace, reduced nuisance
  - Impact reduction for neighbourhood → social benefit
  - Prefabrication in optimised places, reduced welding → safety, reduced cost
- Reduced logistic and delays
  - Millau: 8000 less trucks compared to a concrete bridge → safety, social benefit
  - Early brought into service → increased pay-back, social benefits
  - Reduction of accidents → safety
- High lifespan
  - Iron Bridge (Birmingham) : dated 1779; Millau: 120 years

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Life Cycle Analysis: a key tool for sustainable decision making …

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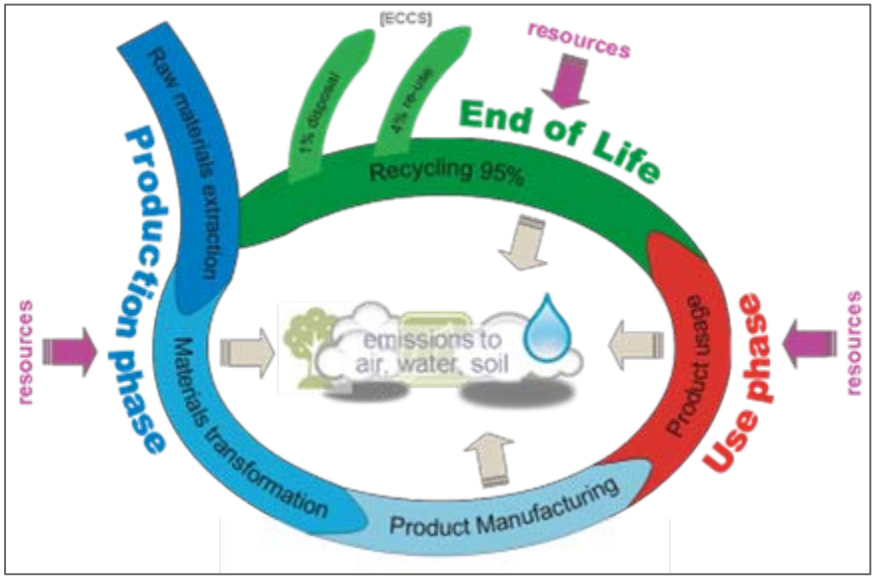
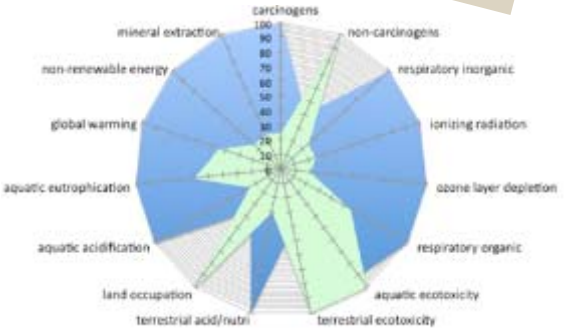
Principle



ISO 14040 – 44

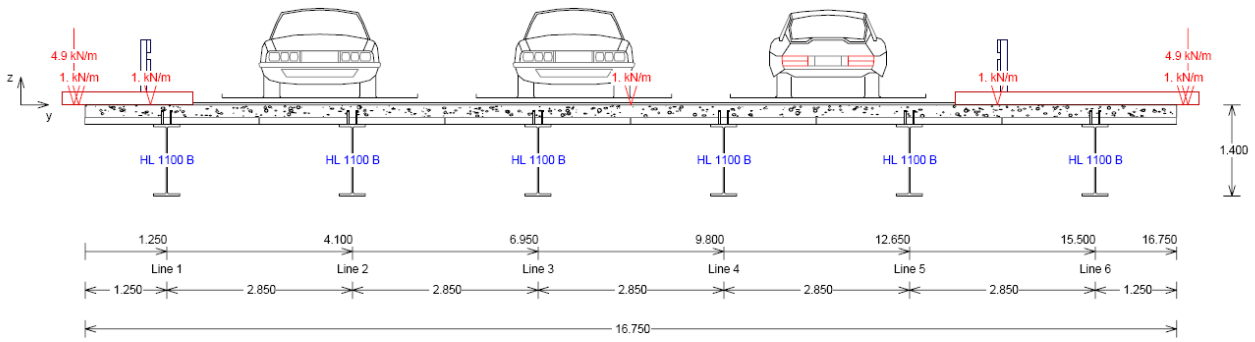


Why is it important?

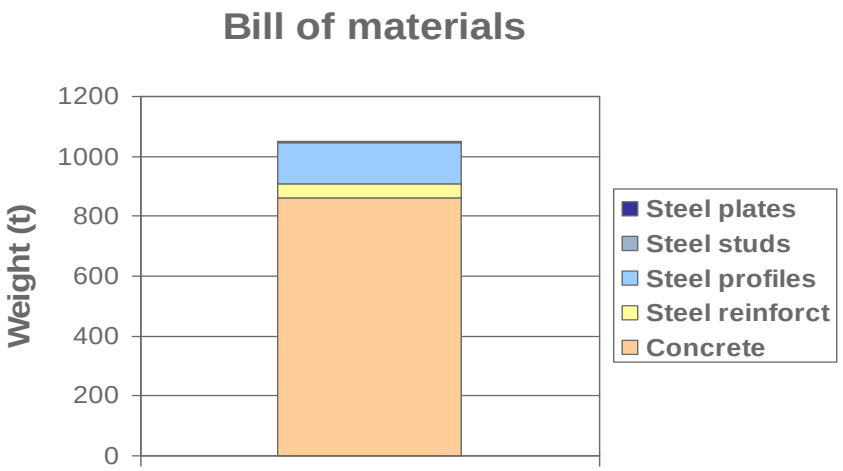
- Choices of consumers or decision-makers will be driven by the environmental performance of products and solutions
  - Environmental labeling of products
  - Environmental product declaration in construction sector
- LCA is a reference methodology to assess this performance

Case study: LCA of a two-span bridge description

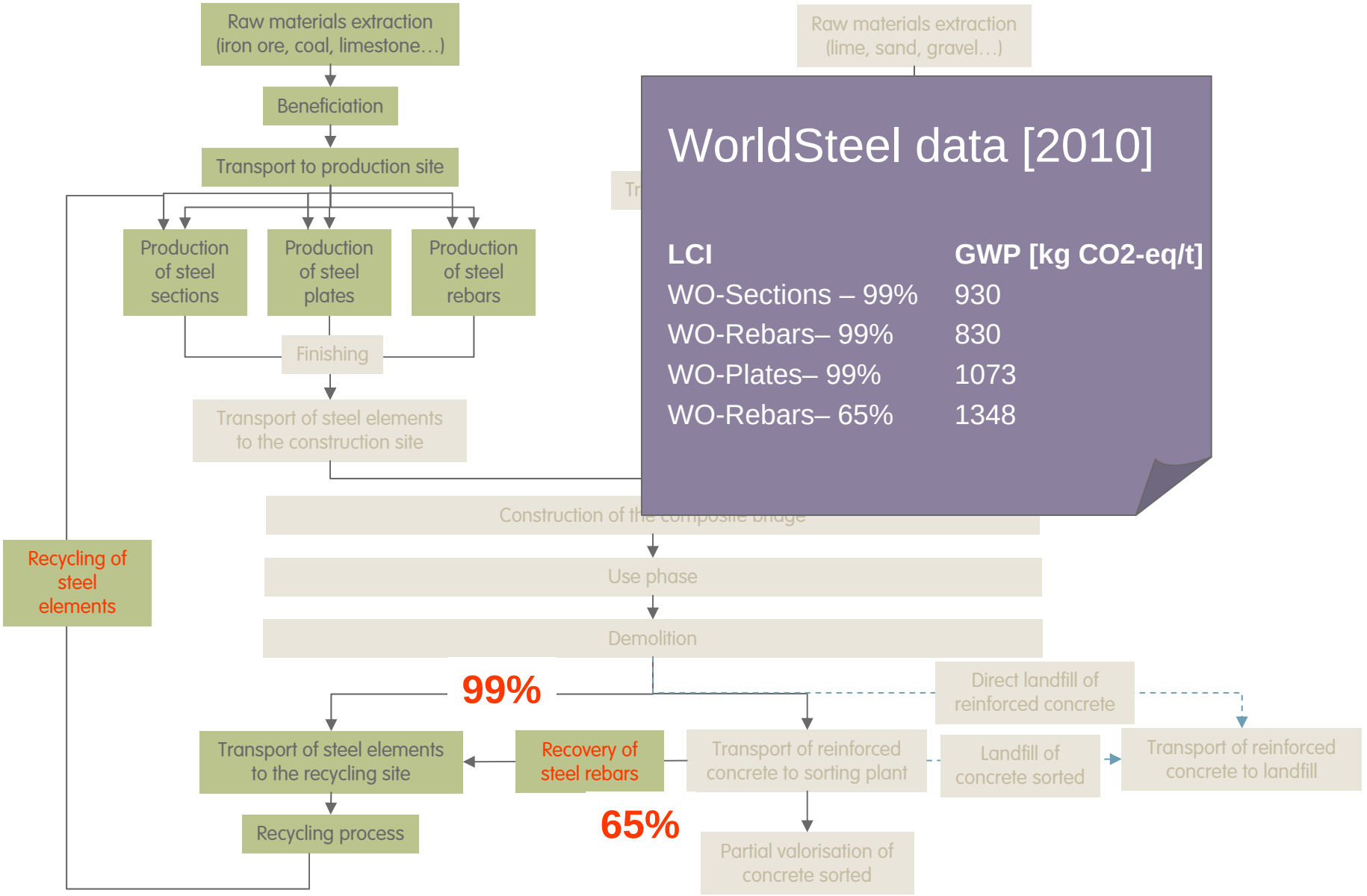
Functional unit: Two-span road bridge with spans of 2 x 29,27m. Composite bridge with partially pre-fabricated bridge girders and reinforced concrete cross girders.



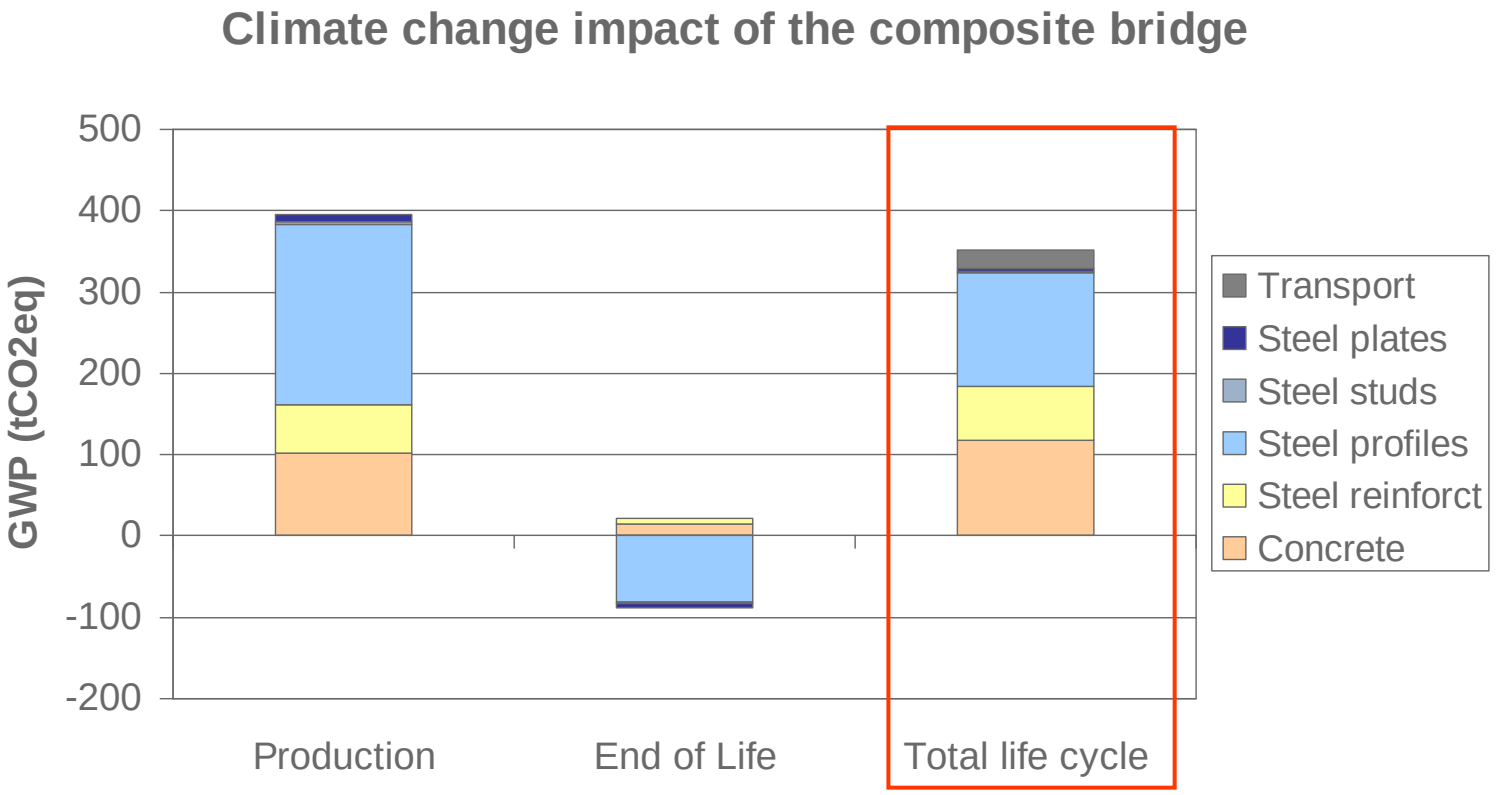
Material	Tonnage [t]
Rolled sections	39
End plates	4
Shear studs	1,56
Concrete	~860
Steel reinforct	47



Case study: LCA of a two-span bridge
steel production and end-of-life



Case study: LCA of a two-span bridge
life cycle results



- Materials production is the largest contributor to climate change
- The environmental benefit brought by steel recycling
  - emissions reduces by 21% (88to CO2-eq)
  - savings equivalent to ~ 700 000km driven by regular car!

Limits of LCA as a ‘sustainability tool’

- Do not valorize positive impacts (social and environmental)
- Difficulty to address technical issues like allocation for recycling in particular
- Social impacts: still a partial approach
- LCA = static approach, How to take time into account?
- Global impacts OK, Local impacts No
- LCA = micro-economic evaluation, what about up-scaling?

LCA can’t manage and solve complexity of sustainable decision alone!

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The Sovamat initiative

- The SOVAMAT initiative aims at:
  - **Develop the methodology tools** to evaluate the economic, environmental and social impacts and benefits of our process/products/services
  - Integrate this **new sustainability metrics** in our developments/process/decisions to address **the challenges** of tomorrow's society (climate change, biodiversity, water stress, demography, energy and material needs, …)

- A network of more than **100 partners** has been developed in all disciplines.
- A **web site** has been built to reinforce the networking, to be recognised, to promote the Sovamat Initiative ideas, and to host projects we are involved in. www.sovamat.org

Toward a new metrics: axes of research

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CIRAIG LCA Chair of Research

Introduce time dimension (dynamic LCA & MFA, …)

Develop prospective & foresight scenarios

PACT project

Definition and formulation of social value of materials

people

Improve micro-scale tools (LCA, env. assessment, biodiversity, …)

product

SAM seminars

CIRAIG LCA Chair of Research

Develop macro-economic dimension (MFA, env. economics, …)

commodities

New metrics for integrated sustainable decision-making

The Society And Materials seminars

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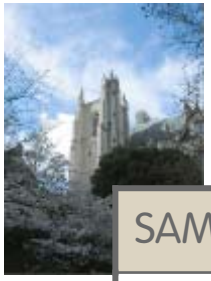
Free, low costs, highly interactive and refreshing



SAM2 Nantes

- 80 participants
- 37 presentations

SAM3 Freiberg

- 50 participants
- 28 presentations

SAM1 Seville

- 85 participants
- 47 presentations

SAM4 Nancy

- 65 participants
- 28 presentations

PACT Project: Pathways for carbon transition

- A collaborative project in the 7th Research EU FP
- Project objectives
  - To shape what a sustainable post-carbon society would look like
  - How we could reach it within the next 50 years
  - Focus first on what shapes the energy demand and evolution, from two viewpoints:
    - infrastructures, (urbanisation and land-use schemes),
    - life-styles and behaviours, in relation to the technologies that should be available

  - Objective for us : to crosslink scenarios at 2050 horizon with demand for structuring materials – metals, cement at least
  - Next deadline: draft report by the end of this year

PACT Project: some results and perspectives

Service	Specific Technologies	Main materials
Construction / Maintenance	Dry building works Assembling-based technologies Green roofs	Steel Concrete – bricks – stones Wood
Thermal comfort	Thermal bridges avoidance Thermal inertia control Solar radiation control	Insulation materials Glass Metals Wood
Lighting	LEDs	Plastics/polymers Metals
Sanitary comfort	Damp control Air exchange	Metals Plastics
Energy supply	Heating/cooling pumps Stationary fuel cells Solar panels Wind mills Biomass	Metals Plastics Wood

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Energy emissions of important material sectors

		today		2050	
		GJ/t		GJ/t	
steel					
Integrated		17	BP	10,3	BT R&D
Electric Arc Furnace		3,5	BP	15,3	BT R&D
Steel Sector		13	BP	3,15	BT R&D
aluminum					
primary electrolysis	SA	100	RM, IP & ES	70	improved electrolysis technology (drained cathodes and inert anodes)
primary carbothermic			BT	54	future development, not a commitment of the sector
secondary	SA	3-9	none	5,5	
aluminum sector	JPB	71,7	JPB	50,7	
cement	SA	4,25	IP	3	assuming progress in cement production and no change of formula
wood	SA	4-6	?		
glass	SA	7	RM, IP & ES	4,5	
plastics					
LDPE	BP	8,5	BP	6,0	
HDPE	BP	5,4	BP	3,1	
Polypropylen	BP	3,6	BP	2,3	
PVC	BP	3,8	BP	3,4	

Idem transports

Poles model
Scenario analysis on urbanisation in the future

Material demand and Energy

SA Sector Average, **BAT** Best Available Technology, **BP** Best Practice, JPB my estimate, **BT R&D** Breakthrough R&D, **BT D** Breakthrough demonstrator (present stage of ULCOS), **ES** Expert Suggestion (like IEA), **RM** Roadmap, **NT** Normative Target, **IP** Incremental Progress

Conclusions and Perspectives

- Steel is a sustainable material, with high social value
- Steel is constantly reinventing itself to be part of the solution, not part of the problem

- Environment is not the only stake
  - Social benefits, economical stakes have to be part of the process of sustainable development

- Current methods are limited and not perfect, they have to evolve
  - Necessary to question the current methods
  - The world is complex, so are decisions
  - Necessity to develop new metrics for sustainability assessment

"The world cannot succeed without business as a committed solution provider to sustainable societies and ecosystems"

WBCSD President Bjorn Stigson