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ALICE Workshop
Zero emission freight and logistics



FUTURE
INVENTER LA VILLE DE DEMAIN



Infrastructures evolutions to support zero emission road freight and logistics





SOCIAL ISSUES RELATING TO MOTORWAY MOBILITY

1

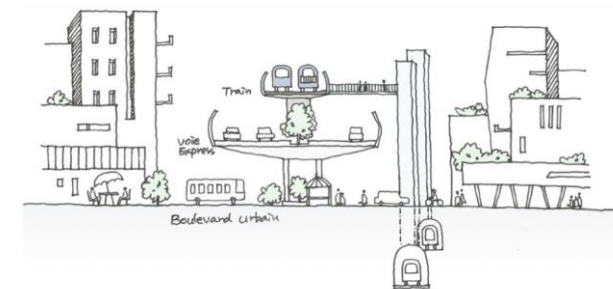
STATE OF THE ART

THREE TECHNOLOGICAL PARADIGM SHIFTS AND FOUR GENERATIONS OF ROADS

- 1st road generation: The pathway
- 2nd road generation: The roman road
- 3rd road generation: The smooth road
- 4th road generation: The motorway
 - First development in the early 20th century
 - Full development of freeway from the 60s-70s
 - Mitigation and adaptation since the 80s
- 5th road generation – R5G ©?
 - The Forever Open Road: A road infrastructure that takes the best of existing technologies and the best of those to come.

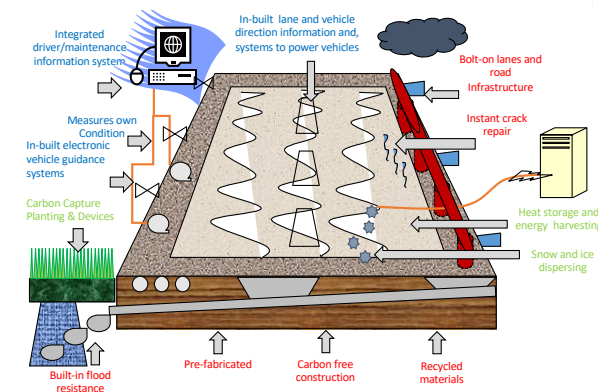


19th-20th century



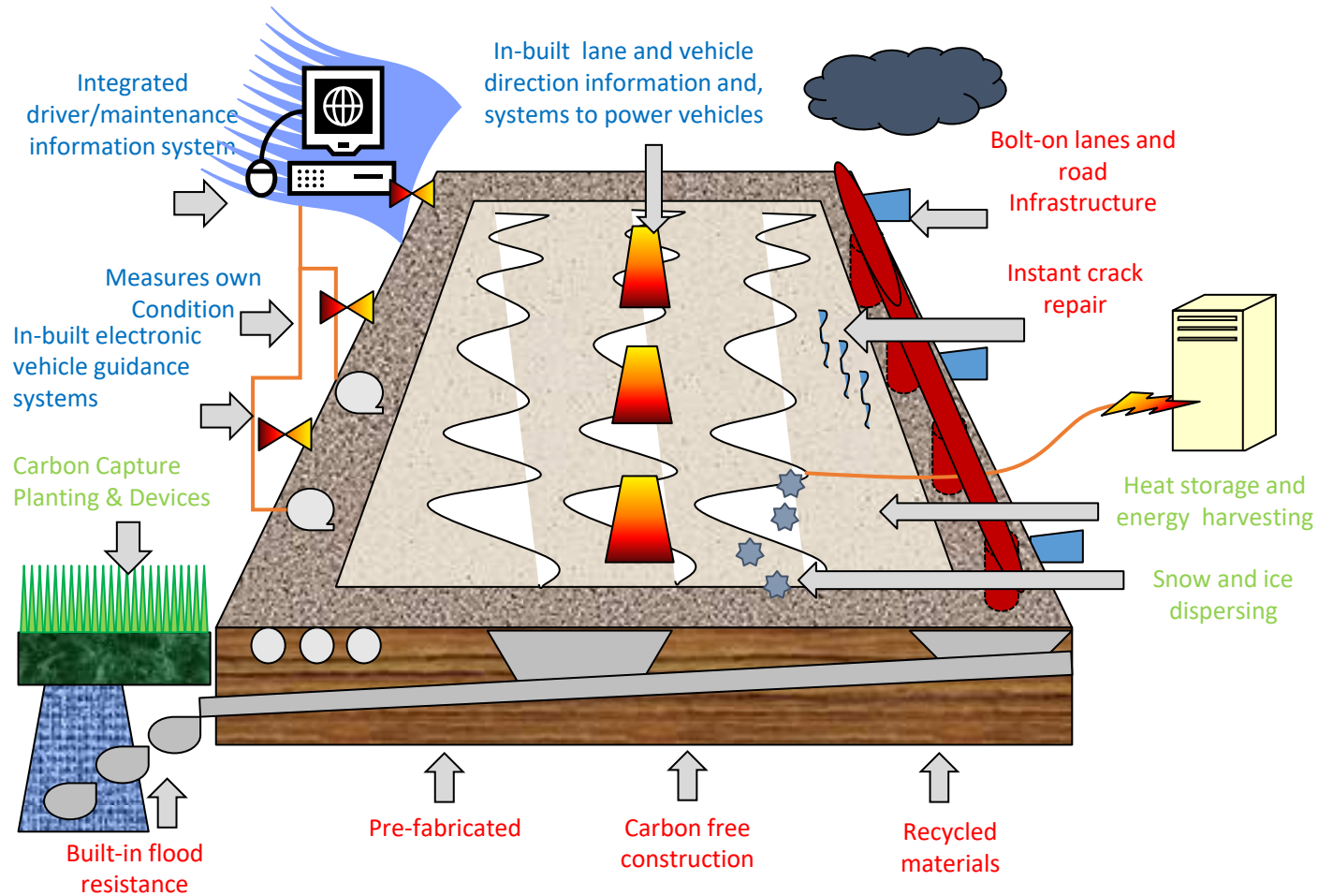
End of 20th century

Porzamparc
Atelier Grand Paris



21st century

THE FOREVER OPEN ROAD (2011)





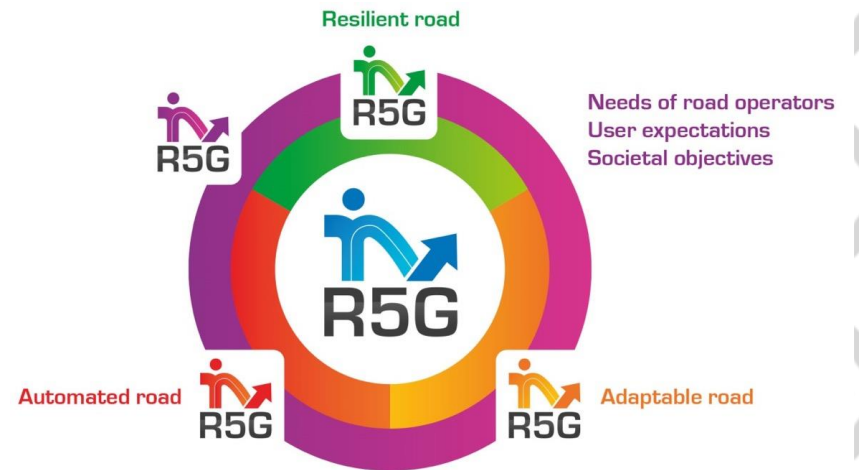
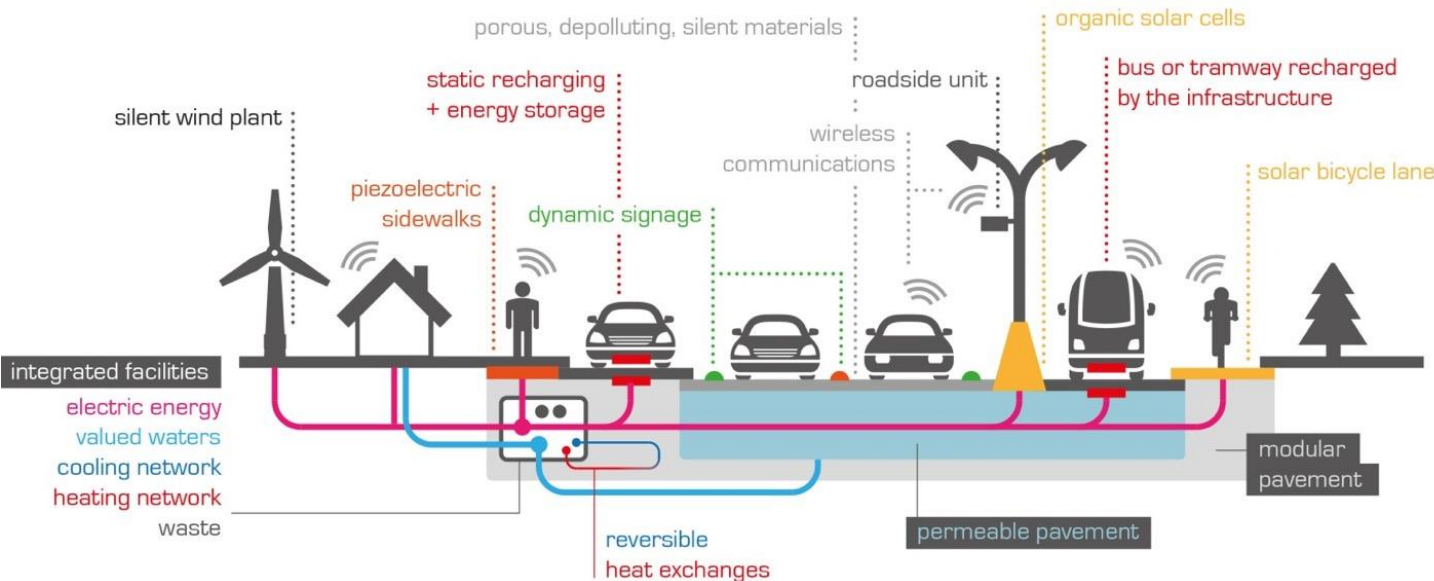
THE ROUTE 5^e GÉNÉRATION PROGRAM - R5G

2

THE 5TH GENERATION ROAD (2011)

THE R5G CONCEPT

- R5G project aims at integrating the different components of the Forever Open Road following a systemic approach to design and build full scale demonstrators of the next generation road

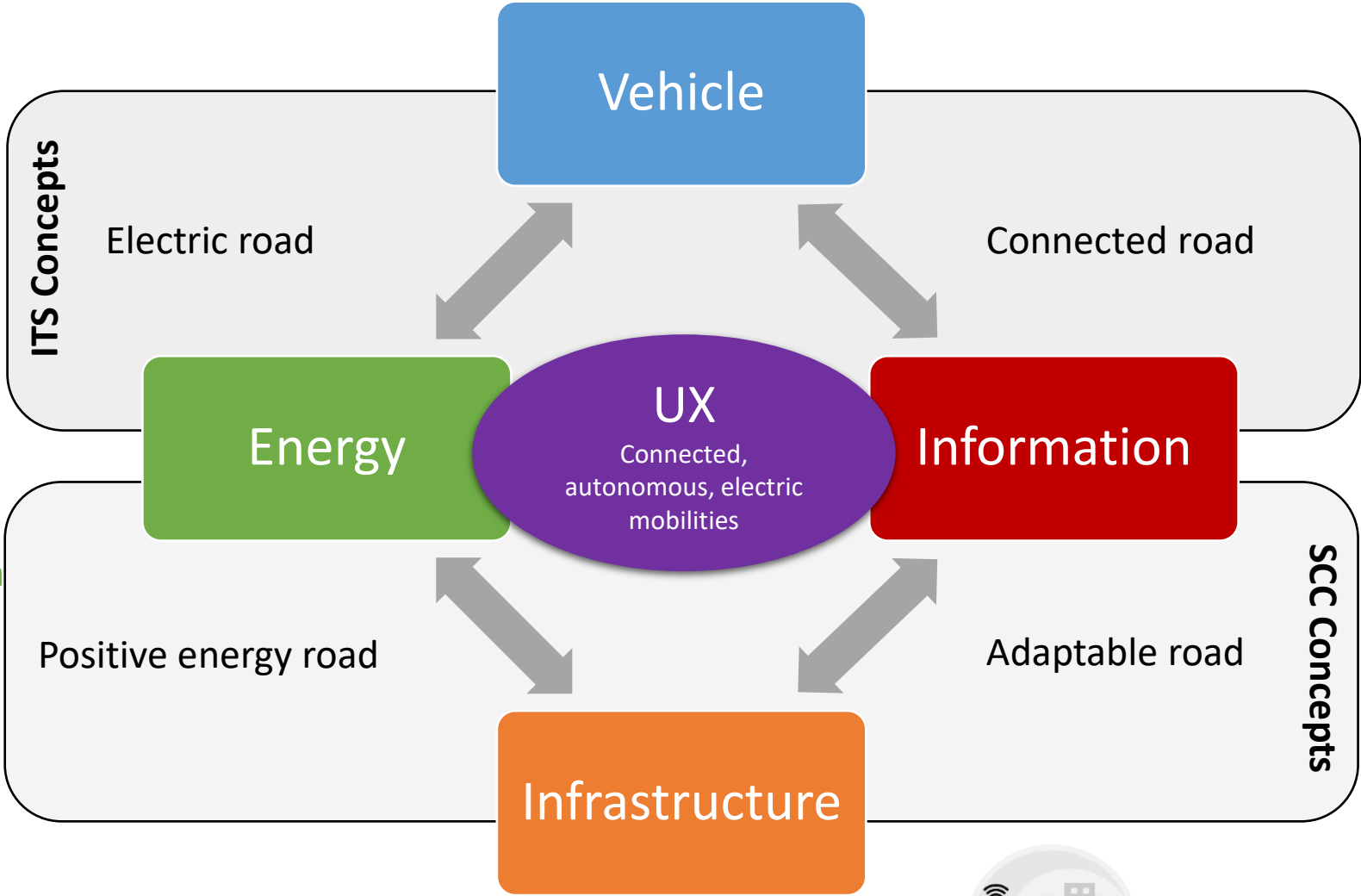


La roadmap "évolutions de la route" : route de 5e génération : route communicante / Nicolas Hautière in *Revue générale des routes et de l'aménagement (RGRA)*, (2018)955 (Juin 2018)

FROM VIC TO VI₂E DESIGN MODEL

Less CO₂
Less emissions
F²BRIC

Smart and clean
energy



Mastered congestion
Increased safety



Optimized use
and maintenance



New services
Optimisation of public space



OPTIMIZING SoS VI₂E PAVES THE WAY FOR E+C- REGULATION ON ROADS

- We are collectively inventing the E+C- regulation of the road through new interactions between the components of the R5G
- On the one hand, the energy integrated road produces and transfers decarbonized energy to road and street components, generating E+ and C-.
- On the other, the automated road generates C- through the new functions and services it implements.
- Research perspectives: environmental assessment or even LCA of R5G

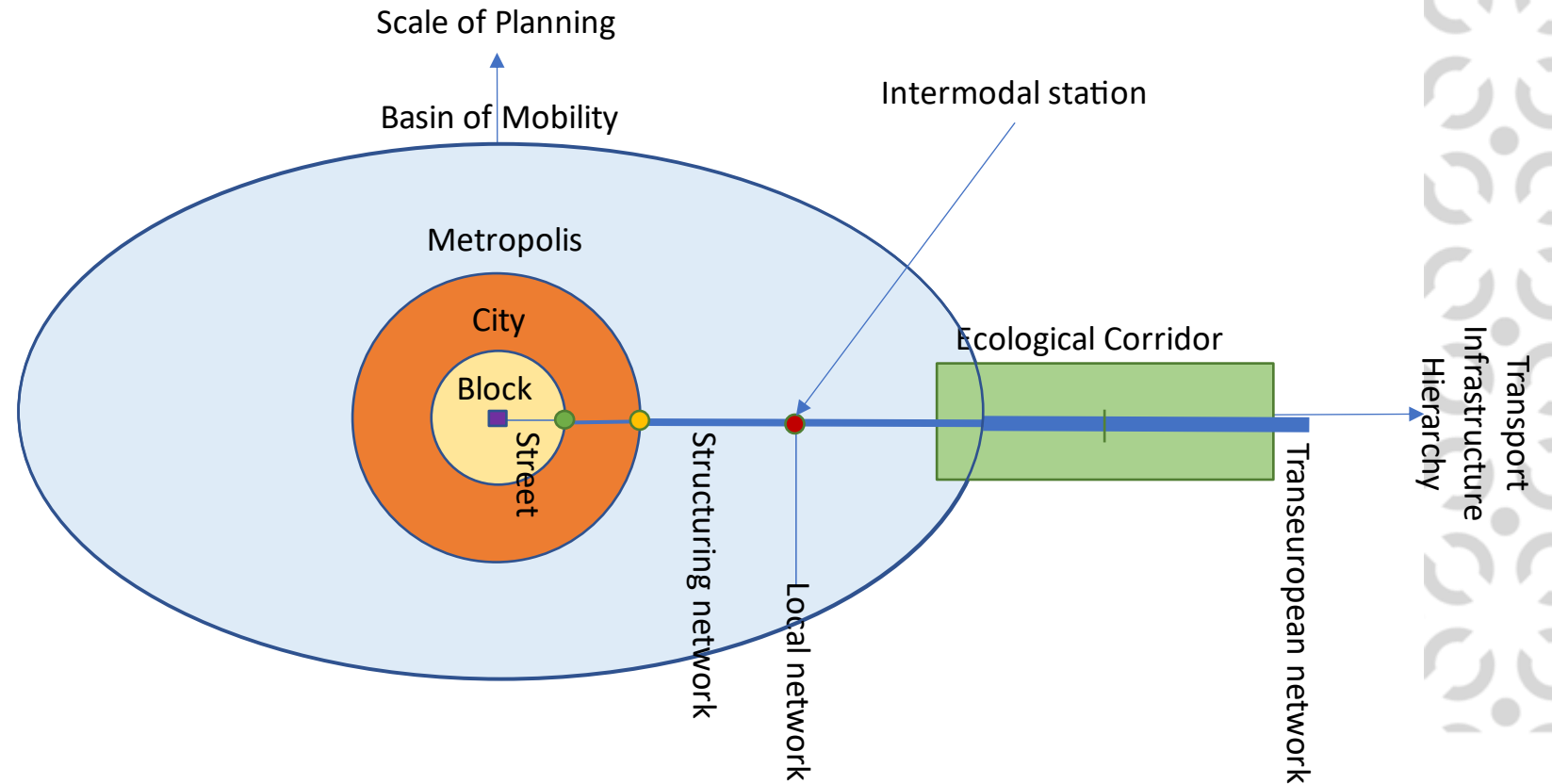
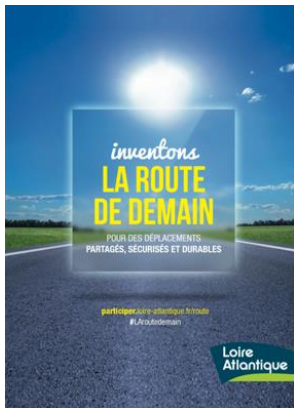
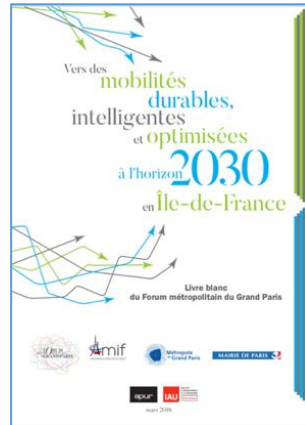




MAKING R5G AN INTEGRAL PART OF CITIES AND REGIONS

3

THE R5GFAB AIMS TO ACCELERATE THE PROJECTS OF TERRITORIES



- The main reason for the requests for intervention are the metropolitan thromboses: Bordeaux, Nantes, Lyon, Lille, Paris, Strasbourg, Marseille...
- The transformation of VSAs into a new type of urban boulevard, the adaptation of networks to new forms of mobility or positive health streets are the main requests.

PERI-URBAN NETWORKS: FROM MULTIMODAL MOTORWAYS TO ROAD TRAINS

- On peri-urban motorway networks, the challenge is to develop the infrastructure to enable them to accommodate means of transport with higher occupancy rates
- As automation progresses, it is possible to envisage the transformation of dedicated lanes into real road trains, probably decarbonised

Current situation

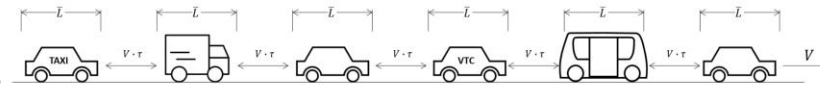


Coach on auxiliary lane



Carpool lane

TRAINS ROUTIERS...



Future situation

Vitesse	φ _{max} Débit maximum de véhicules par heure et par voie									
	500	1 000	1 500	2 000	2 500	3 000	3 500	4 000	4 500	5 000
130 km/h	7,0s	3,4s	2,2s	1,63s	1,27s	1,03s	0,86s	0,73s	0,63s	0,55s
120 km/h	7,0s	3,4s	2,2s	1,62s	1,26s	1,02s	0,85s	0,72s	0,62s	0,54s
110 km/h	7,0s	3,4s	2,2s	1,60s	1,24s	1,00s	0,83s	0,70s	0,60s	0,52s
100 km/h	7,0s	3,4s	2,2s	1,58s	1,22s	0,98s	0,81s	0,68s	0,58s	0,50s
90 km/h	7,0s	3,4s	2,2s	1,56s	1,20s	0,96s	0,79s	0,66s	0,56s	0,48s
80 km/h	6,9s	3,3s	2,1s	1,53s	1,17s	0,93s	0,76s	0,63s	0,53s	0,45s
70 km/h	6,9s	3,3s	2,1s	1,49s	1,13s	0,89s	0,72s	0,59s	0,49s	0,41s
60 km/h	6,8s	3,2s	2,0s	1,44s	1,07s	0,84s	0,67s	0,54s	0,44s	0,36s
50 km/h	6,8s	3,2s	1,97s	1,37s	1,01s	0,77s	0,60s	0,47s	0,37s	0,29s
40 km/h	6,7s	3,1s	1,86s	1,26s	0,90s	0,66s	0,49s	0,36s	0,26s	0,18s
30 km/h	6,5s	2,9s	1,68s	1,07s	0,72s	0,49s	0,31s	0,18s	0,08s	-
20 km/h	6,1s	2,5s	1,33s	0,77s	0,49s	0,12s	-	-	-	-
10 km/h	5,6s	1,44s	0,24s	-	-	-	-	-	-	-

$$\tau = \frac{1}{\phi} \cdot \frac{L}{V}$$

Distance moyenne intervéhicules

Manuel
VA
V2V / V2I
Impossible

φ = Nφ

Débit de passagers par heure

= Route
= Bus
= Tramway / RER
= métro/RRR



TRAPEZE

Source : Laurent Taupin - ECOV

Université Gustave Eiffel

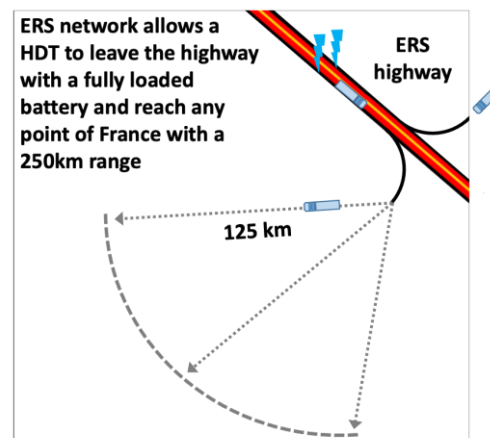
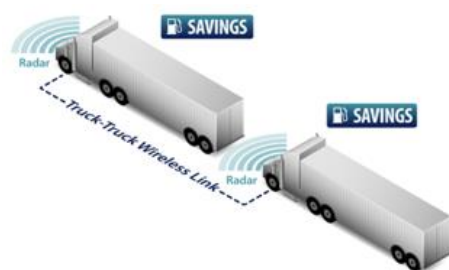
LONG-DISTANCE NETWORKS: AUTOMATION AND DECARBONISATION OF FREIGHT TRANSPORT

ELECTRIC ROAD SYSTEMS

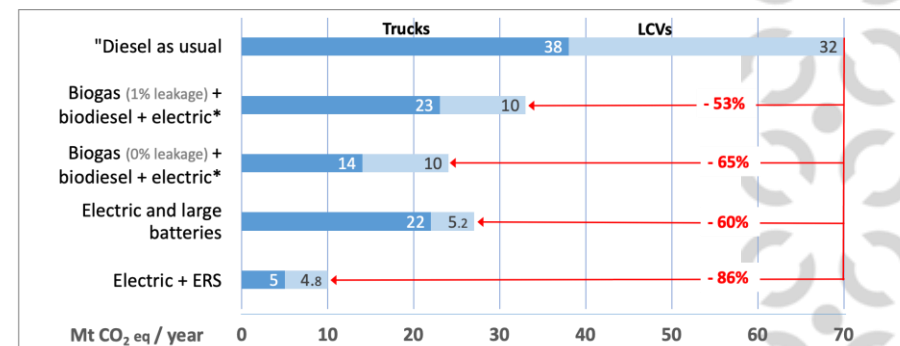


TRUCK PLATOONING

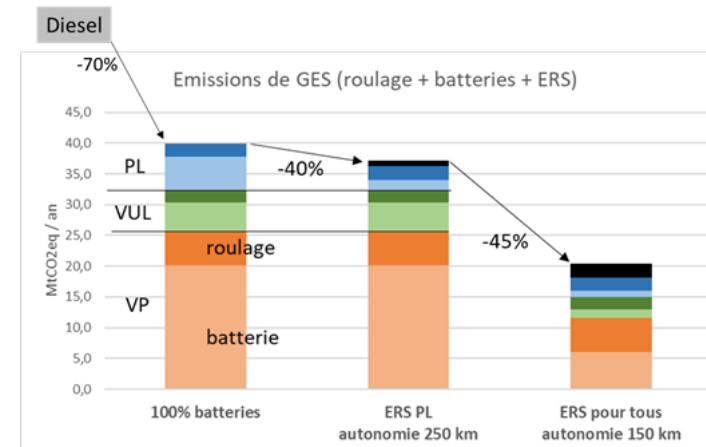
- Reduction of costs and delays
- Improved productivity
- Reduced driver anxiety
- Increased safety through fewer human errors
- Reduced emissions and fuel consumption (10%)
- Increased road capacity, reduced congestion
- A solution to the lack of drivers



GHG emission gaps /year in Life Cycle Analysis (2040) France data



Source : Pelata et al., 2021



Source : F. Perdu, 2021

LOCAL NETWORKS: IMPROVING TERRITORIAL SUPPLY

Autonomous shuttles

Take advantage of autonomous mobility solutions to decarbonise everyday mobility and adapt at least the existing infrastructures in a cross-modal approach.

FERROMOBILE



Cœur de Brenne – ENA Project

 expérimentations navettes autonomes



Rambouillet –TORNADO Project



Ultralight trains



FLEXMOVE Project – AKKA/ALSTOM

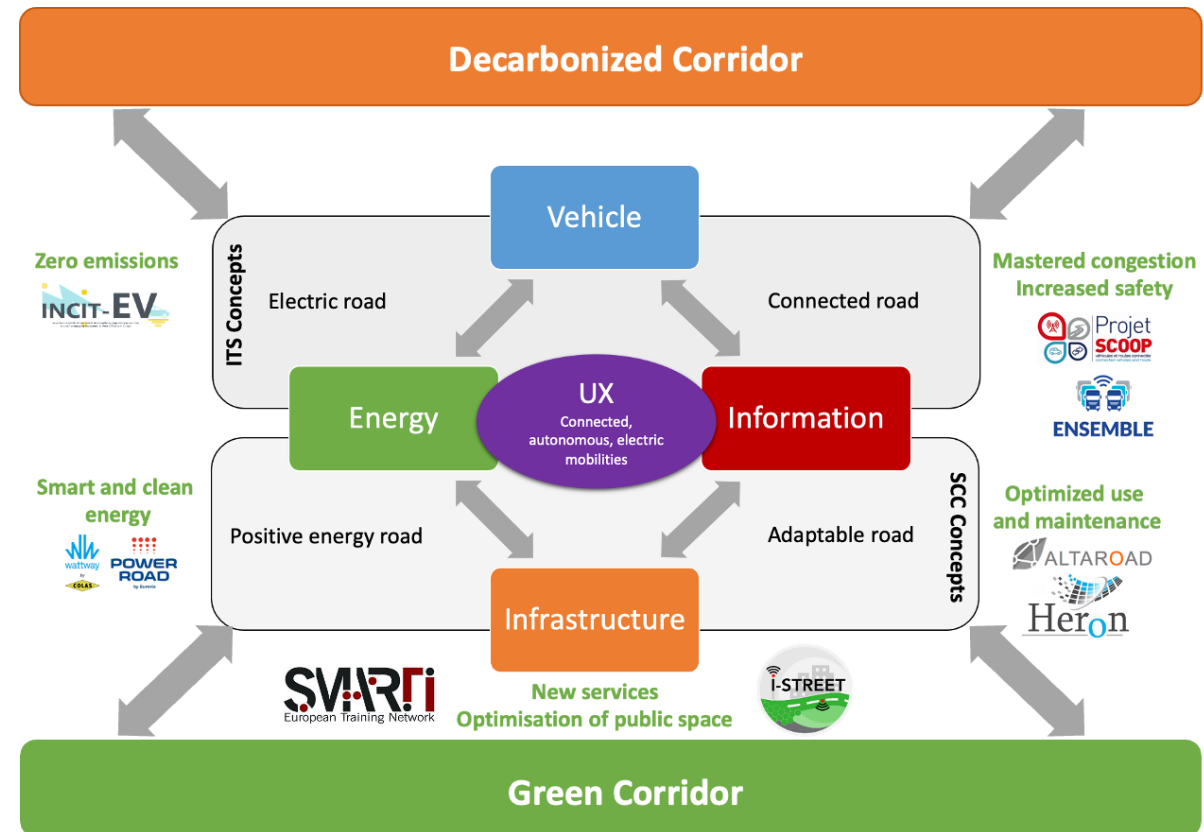
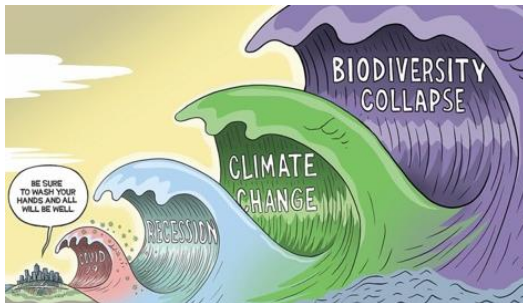


**THE R5G - A ROAD WITH A
POSITIVE ENVIRONMENTAL
CONTRIBUTION?**

4

THE VI₂E FRAMEWORK IS STILL INSUFFICIENT, AND WE NEED TO ADD THE ENVIRONMENT IN WHICH THE ROAD IS LOCATED.

- Road emissions, in particular CO₂, do not only concern the road itself, but the environment in general.
- If we reason locally, CO₂ emissions concern the immediate atmosphere and the areas crossed by the road.
- This makes it possible to draw up a more global framework for thinking about the role of infrastructures in decarbonizing the green corridors crossed by transport infrastructures, including NBS in particular.



A ROAD THAT CONSUMES OR STORES CARBON

CO₂ capture by trackside production units

- The ANR CANOPEE project has developed concepts for microalgae production.



CO₂ storage by recarbonation of recycled aggregates

- IREX FastCarb project studies storage processes based on recycled concrete aggregates



Stockage de CO₂ par carbonatation du béton recyclé

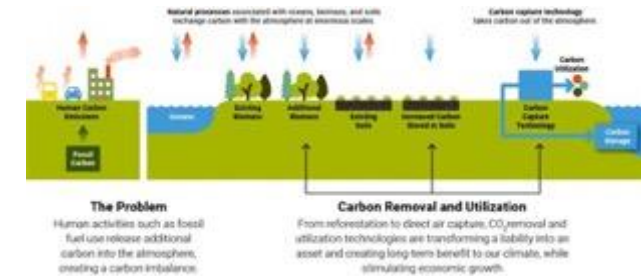


- The E3S project applied this technique to the LaVallée eco-district in Chatenay-Malabry.



CO₂ capture or negative emission solutions

- The aim of these geo-engineering techniques is to remove more CO₂ by "afforestation" or reforestation, by changing the nature of the soil or by capturing it directly.



- The challenge is then to valorize this CO₂ in sectors such as biofuels, food or agriculture.
- By default, CO₂ can be sequestered underground, but acceptability is limited.

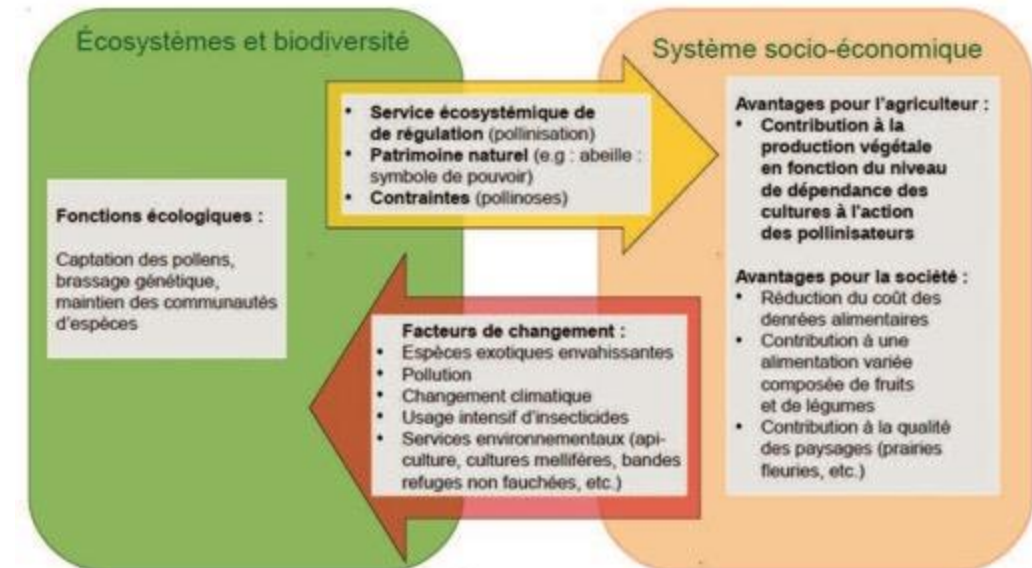
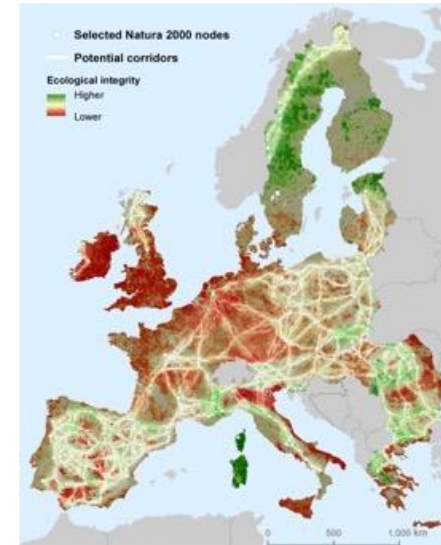


ROAD AS A CORRIDOR OR HABITAT FOR BIODIVERSITY



ITTECOP
Infrastructures
de transports terrestres
écosystèmes et paysages

- The role of LTIs in the fragmentation of natural habitats is fully recognized. To date, the potential of LTIs as habitats or biodiversity corridors remains controversial.
- However, in a context of shrinking natural habitats, exploiting these areas to contribute to wildlife conservation cannot be ruled out
- These ecosystem services can contribute to the agro-ecological transition.
- In addition, these corridors can enable species to migrate to adapt to climate change.

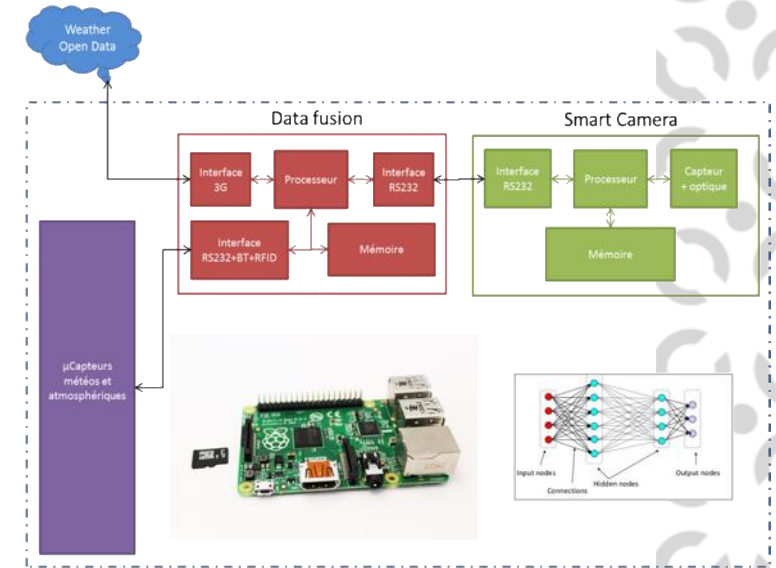
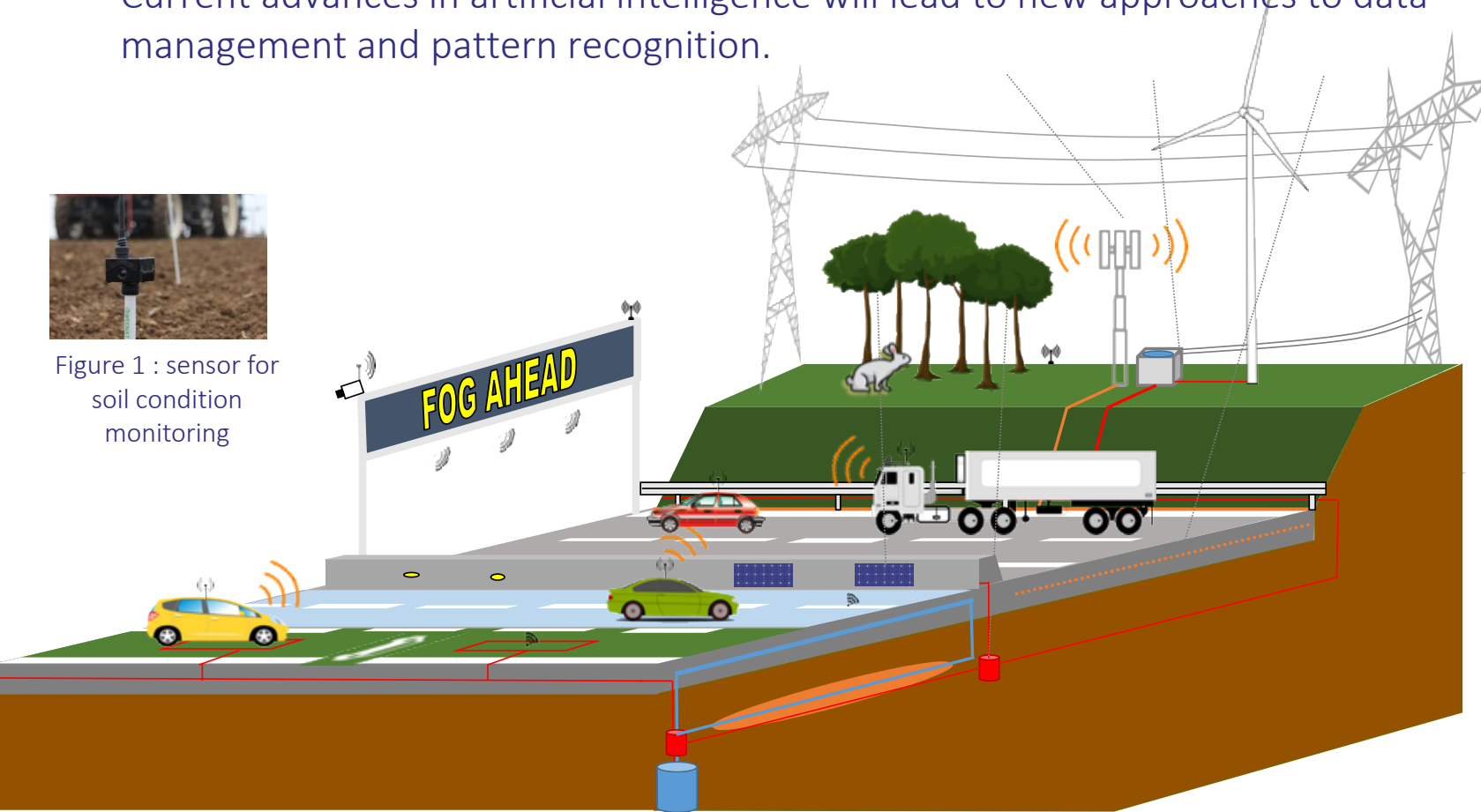


A ROAD THAT MONITORS THE STATE OF THE ENVIRONMENT AND BIODIVERSITY

- Increasing road connectivity and advances in sensor technology will gradually transform road infrastructure into an "opportunistic" surveillance tool, including satellite-based surveillance.
- Current advances in artificial intelligence will lead to new approaches to data management and pattern recognition.



Figure 1 : sensor for soil condition monitoring



N. Hautière, F. Bourquin. Instrumentation and monitoring of the NextGen road infrastructure: Some results and perspectives from the R5G project, EGU General Assembly, Vienna, Austria, 2017

CONCLUSION AND PERSPECTIVES

- New-generation roads and streets will be increasingly automated and energy-integrated to meet societal challenges.
- The R5G project aims to design demonstrators of the roads of the future throughout France, and to assess their ability to meet the challenges facing society today.
- The various French regions are working in this direction, as demonstrated by the "Routes du futur du Grand Paris" competition organized by the Forum Métropolitain du Grand Paris, which aims to solve the challenges of periurban mobility in everyday life, in particular by massifying urban freeways.
- In intercity areas, the challenge is not only to decarbonize long-distance freight transport, but also to rethink the relationship between freeways and territories, and to propose a "closed" approach between town and country, making it possible to achieve the SDGs.
- In urban environments, the challenge is to successfully transform urban arteries into health-positive streets.
- In this context, digital technology is seen as an essential solution, alongside the development of new materials and processes to improve the resilience of roads to climatic and man-made hazards.

LES ROUTES DU FUTUR DU GRAND PARIS

ET DANS 11 SITES FRANCILIENS

Infos : www.pavillon-arsenal.com/ www.routesdufutur-grandparis.fr

