A smart and sustainable vision when assessing a smart urban renovation project. An application example

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L'institut pour la transition énergétique de la ville

Who are we?

6 leading industrial groups

EDF, ENGIE, VEOLIA, RATP, VINCI, IBM

7 engineering firms

abmi matching people, ARCADIS, assystem, INGÉROP Inventons demain, suez consulting, setec, EPF L'INGÉNIERIE CO-CRÉATIVE

15 public higher education and research institutions

CSTB le futur en construction, IFSTTAR, Cerema, ESIEE PARIS, IGN, École des Ponts ParisTech, MINES ParisTech, Éa v&t, ESTP, EIVP, malaquais, paris-belleville, Université Paris-Est, UPEM Université Paris-Est Marne-la-Vallée, université Paris-Saclay

	Etat	Membres privés
Actionnariat :	49%	51%
	Etat	Membres & partenaires
Budget R&D : 6 M€/an dont :	50%	50%

100 researchers and experts gathered on a single site in multidisciplinary project teams

at the Cité Descartes : French centre of excellence on the sustainable city (future G. Eiffel University)

Smart and sustainable urban districts are part of the key clues to address the challenge raised by cities' impact on climate change.

- Huge CC mitigation potential related to current inefficiencies at the city level:
  - urban energy is too segmented (electricity, gas, heat, etc.) without any real coordination
  - energy solutions and networks are oversized and poorly rely on renewable/ recovered energy
- Cities are likely to rely on the urban district scale to be energy efficient
  - as an integrated system with a complete value chain with different stakeholders
  - by the development of energy community solutions such as district heating strongly relying on renewable energy sources (RES)-or quite large PV facilities for self-consumption
- This urban leverage effect on CC mitigation is also crucial as cities will stand for 2/3 of the world population towards 2050 and since they dominate energy demand

However, this crucial role of cities in climate change mitigation is conditioned by

- The ability to involve all stakeholders in an urban project and is directly linked to the energy efficiency solutions deployed
- Using relevant assessment approaches with a scope beyond classical Life Cicle Assessment methods (Investment + operating costs) due to:
  - Poor payback period of innovative and efficient energy-related investments
  - The existence of economic, environmental & social co-benefits to take into account

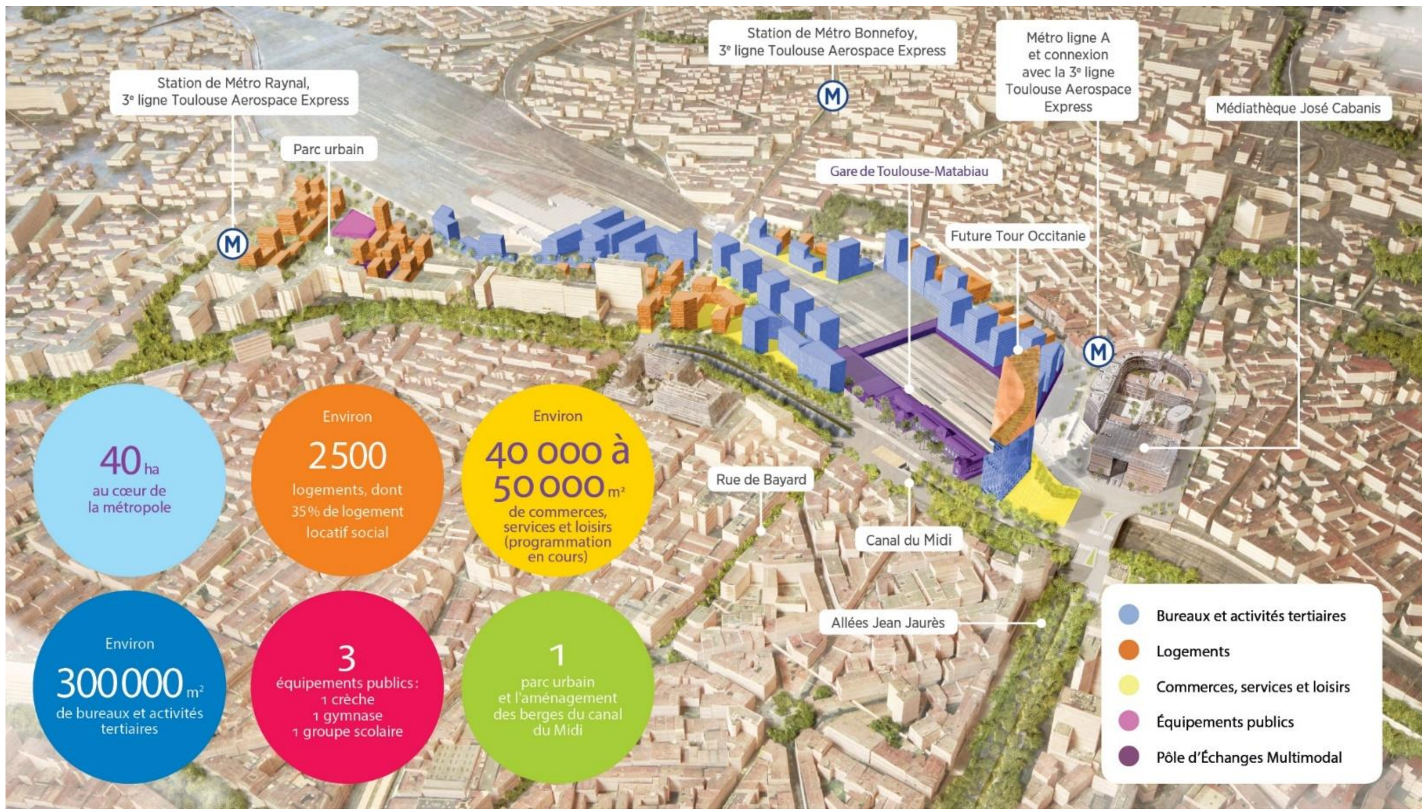
Toulouse EuroSudOuest, an urban renovation project

europolia
spla • toulousemétropole

toulouse métropole

La Région Occitanie Pyrénées - Méditerranée

La RÉGION à énergie POSITIVE



An energy development project in Toulouse City in the frame of an urban planning

- Matabiau station district (multimodal interchange center) under renovation
  - Existing buildings with new or renovated energy systems
  - Buildings to be built
  - Train station to renovate
- Neighboring Urban Development Area(ZAC TESO)

Local energy production sources

- Sources of thermal energy production
  - Geothermal energy on the moulded walls of the underground station & car parks
  - Calorie recovery on the Canal du Midi channel
- Distributed electricity generation sources
  - Recovery of residual braking energy from subway & trains
  - Solar PV energy

Defining scenarios for assessment

Need to define coherent scenarios for the evaluation:

- A thermal scenario: insulated thermal installations vs. a mutualisation of needs/production of heat and cold on a variable scale
- An electricity scenario: implementation of renewable electricity production infrastructures and degree of mutualisation at the district level

Three energy development scenarios

- Reference: Each building has its own thermal solution, no PV
- Advanced:
  - Potential for local heat recovery using a temperate water loop (PEM)
  - Electric community: production and sharing of electricity from distributed sources
- Full integration:
  - Potential for local heat recovery using a temperate water loop (PEM+ZAC)
  - Electric community: production and sharing of electricity from distributed sources

Investments costs spread on 2020-2040 period (progressive urban development)

Large differences between the scenarios from the point of view of classical LCC

Systems	Reference scenario	Scenario 1	Scenario 2
Condensing boiler (individual and mutualized)	3435 kW Existing 750 kW Additional (2020 until 2040)	3435 kW Existing 750 kW Additional (2020 until 2040)	3435 kW Existing 3700 kW Additional (2020 until 2040)
Cooling Units	2440 kW Existing	2440 kW Existing 2577 kW Additional (2020 until 2040)	2440 kW Existing 13739 kW Additional (2020 to 2040)
Aeraulic Heat Pumps	387 kW Existing 13120 kW Additional (2020 until 2040)	13920 kW Additional (2020 until 2040)	387 kW Existing
Geothermal Heat Pumps	-	838 kW Additional (2020)	8838 kW Additional (2020 until 2040)
Temperate network (ml)	-	1400 (2020)	13090 (2040 to 2040)
Photovoltaic and electric community	-	1600 kWc (2020)	1600 kWc (2020 until 2040)
Breaking energy recovery	-	2100 kWc (2020)	2100 kWc (2020)
Overall investment cost	M€ 2.6	M€ 9.7	M€ 20.6
Overall Operation costs (excl. energy)	M€ 3.4	M€ 13.3	M€ 35.4

Identification and valuation of co-benefits

Co-benefits identified for the analysis:

- Employment impacts: jobs mobilized as a result of energy transition investments in each scenario (directly and indirectly)
- Health impacts: reduction of particulate emissions through the development of brake energy recovery
- Contribution to the fight against climate change by reducing CO2 emissions

Impact in jobs (Full-Time Equivalents)

Scope: Occitania Region

1. Identification of the technical solutions mobilized in the different scenarios.
2. Quantification of sectoral value-added (VA) activities
3. Use of input/output tables (TES) to assess the VA of the activities of the other branches mobilised by the activities of points 1 and 2
4. Assessment of the negative a priori impact of the substitution of historical energy solutions by renewable and local solutions
5. Conversion of estimated VA to 3 & 4 FTEs based on sector ratios
6. monetization on the basis of an expenditure ratio of the Occitan region for economic development related to the number of jobs created.

Impact in jobs (Full-Time Equivalents)

The approach will be carried out using the TETE ® tool which

- Is developed by ADEME (French Environment and Energy Efficiency Agency) and Climate Action Network
- assesses the employment benefits of an energy transition program according to the technical solutions adopted and on a given territorial scale (from the national territory to the municipality).
- estimates direct and investment-induced employment.
- relies on the principle of the input-output table to analyze the creation and destruction of jobs in the industries affected by these actions (INSEE data).

Données d'entrée

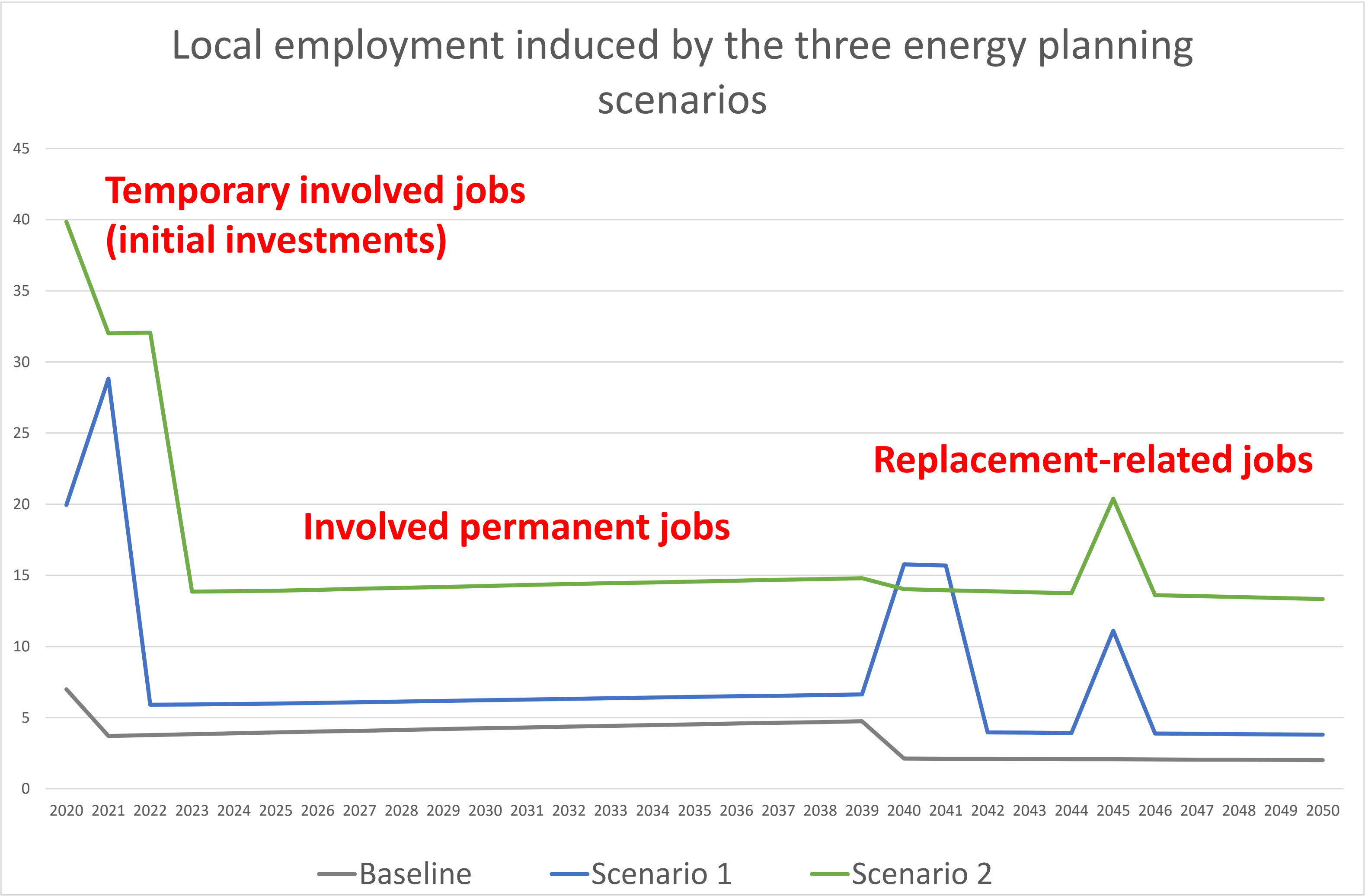
Niveau géographique pour les sorties (0 : national seulement ; 1 : département ; 2 : ancienne région ; 3 : nouvelle région ; 4 : ensemble de communes) 3

Code du département ou de la région (cf. onglet "codes_geographiques"): 76

Activité	Unité	2 018	2 019	2 020	2 021	2 022	2 023
énergies renouvelables							
éolien terrestre							
capacité installée dans l'année	MW						
éolien maritime							
capacité installée dans l'année	MW						
PV au sol							
capacité installée dans l'année	MW						
PV grandes toitures							
capacité installée dans l'année	MW						
PV petites toitures							
capacité installée dans l'année	MW						
chauffe-eau solaires individuels (CESI)							
surface installée dans l'année	milliers de m²						
chauffe-eau solaires collectifs (CESC)							
surface installée dans l'année	milliers de m²						
PAC géothermiques individuelles							
capacité installée dans l'année	MW						
PAC aérothermiques							
capacité installée dans l'année	MW	5		3	1	1	1
Chauffe-eau thermodynamiques							
capacité installée dans l'année	milliers de logements						
petit hydraulique							

		2 018	2 019	2 020	2 021	2 022	2 023	2 024
Résultats : emploi local, en équivalent temps-plein (ETP)								
total		**649**	**624**	**974**	**1 045**	**1 124**	**1 203**	**1 280**
	sous-total énergies renouvelables	**649**	**624**	**974**	**1 045**	**1 124**	**1 203**	**1 280**
	sous-total bâtiment et réseaux de chaleur	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	sous-total transports	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	sous-total énergies fossiles	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	détail énergies renouvelables							
	éolien terrestre	0	0	0	0	0	0	0
	éolien maritime	0	0	0	0	0	0	0
	PV au sol	0	0	0	0	0	0	0
	PV grandes toitures	0	0	0	0	0	0	0
	PV petites toitures	0	0	0	0	0	0	0
	chauffe-eau solaires individuels (CESI)	0	0	0	0	0	0	0
	chauffe-eau solaires collectifs (CESC)	0	0	0	0	0	0	0
	PAC géothermiques	0	0	0	0	0	0	0
	PAC aérothermiques	649	624	974	1 045	1 124	1 203	1 280
	chauffe-eau thermodynamiques	0	0	0	0	0	0	0
	petit hydraulique	0	0	0	0	0	0	0
	chauffage au bois, appareils individuels	0	0	0	0	0	0	0
	chauffage au bois industrie tertiaire et réseaux de chaleur	0	0	0	0	0	0	0
	méthanisation - cogénération	0	0	0	0	0	0	0
	méthanisation - injection	0	0	0	0	0	0	0
	détail bâtiment et réseaux de chaleur							
	rénovation maisons individuelles	0	0	0	0	0	0	0
	rénovation logements collectifs	0	0	0	0	0	0	0
	rénovation tertiaire	0	0	0	0	0	0	0
	construction neuve logements	0	0	0	0	0	0	0
	construction neuve tertiaire	0	0	0	0	0	0	0
	réseaux de chaleur, construction et extension	0	0	0	0	0	0	0

Impact in jobs (Full-Time Equivalents)



Health impact: the approach followed

PM-related impacts

1. Quantification of PM10 and PM2.5 emissions by substitution of braking technologies
2. Conversion of avoided inhalation quantities into health impacts in terms of chronic mortality (YOLL), sudden mortality (YOLL) and morbidity
3. Monetization of the health impact expressed in mortality (YOLL) by the use of tutelary values and of the impact in morbidity by the quantification of health expenditures

NOX-related impacts

1. Mitigation of adverse health effects attributed to NOX emissions coming from gas-fired boilers due to their partial or total substitution in Scenarios 1&2
2. Monetizing of Boiler substitution-related health effect basing on a (national) shadow value of NOX

Contribution to climate change mitigation

The followed approach :

1. Analysis of CO2 emissions by energy vector (operation phase only) of the different scenarios carried out by the EFFICACITY Powerdis tool.
2. Use of a carbon cost (tutelary value) to monetize CO2 emissions for each scenario.

Outcomes

		Reference	Scenario 1
Investment costs over the reference study period	€	2.6 M	9.7 M
Operation costs over the period	€	3.5 M	13.3 M
Energy costs over the period	€	18.6 M	17.3 M
Electrical community over the period	€	0	(9.3 M)
LCC exc. Externalities over the period	**€**	**24.7 M**	**31 M**
CO2 social costs over the period	€	3 M	1.9 M
Health costs over the period	€	13.6 M	7.4 M
Monetized economic development impact over 2020-2050	€	(1.1 M)	(2.4 M)
Overall social & economic costs over 2020-2050	€	40.1 M	37.9 M
Annualized social & economic costs over 2020-2050	€	2.3 M	2.2 M
Social economic value / reference over 2020-2050	€	0	2,2 M
Annualized Social economic value / reference over 2020-2051	€	0	125 k

M€+6.4

M€ (2.2)

The overall socio-economic assessment differs completely from the traditional LCC in that it takes into account the impact on health and economic development

The hereby presented economic assessment method helps to raise the crucial question of the relevant technical and stakeholder scope

- Monetized social & environmental non-energy benefits can shed light on the challenge of determining the economic relevance of a project with a broader point of view and can help to choose the “real” best alternative;
- however, they cannot be used as a “magic formula” able to justify any large RES and energy efficiency project if they turn out to be irrelevant from a technical point of view.

Questions related to players game, transaction and governance are crucial:

- Moving from theoretical monetized values to the determination of an "acceptable expenditure" from stakeholders point of view for the overinvestment related to scenarios with more co-benefits

Player	Role
State	Coordinator of the railway network
Occitanie Region local Authority	Responsible for the public transportation organization
Garonne Department local authority	Management of the Toulouse Main bus Station
Toulouse Metropole Local authority	Responsible for Urban development and energy-related development (at a local scale)
Tisseo	Management of the local public transportation
Europolia	Urban developer
SNCF Réseau	Management of the railway network
SNCF Mobilités	Management of the passenger and freight train traffic
SNCF gares et connexions	Owner and manager of the train stations
SNCF Immobilier	Owner and manager of the real-estate assets (exc. Stations)
Enedis	Power Distribution System Operator (DSO)
Railway companies (Voyages SNCF, SNCF Logistics…)	Producer of braking-recovered energy Competitor on the train transportation market

www.efficacity.com