POCACITO

european post-carbon cities of tomorrow

Barcelona Strategy Paper

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BARCELONA STRATEGY PAPER – TOWARDS A POST-CARBON CITY

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CHALLENGES FACING THE CITY

The POCACITO project has conducted a number of separate studies, starting with an initial assessment of the city to analyse the latest trends over a decade and to see if the city is on a path of decarbonisation with resilient social and economic development.

Barcelona is a leader in the deployment of smart city technology, which is important for sustainable economic growth towards a post-carbon city, but a long-term strategy has to move beyond the technological approach. The city seems to face two challenges that are not currently developing well and may require attention by the city authorities. First is the need to address the challenges of an increased share of the population at risk of exclusion and poverty. The city has focused strongly on the tourism and business attractiveness and is at the forefront of actions in the area of technology and environment. The risk may be a class of marginalised citizens not able to benefit from the advanced city features.

Barcelona is crossing the threshold from being a testing ground for technologies to applying these technologies on a large scale. A greater role for the AMB (Area Metropolitana de Barcelona) as coordinating body for the city may be needed here. The movement is there; the recommendation is to continue, despite the difficulties in the process.

The growing level of municipal indebtedness will require the city to explore new financial models for public procurement and public services, seeking better cost-recovery mechanisms, while ensuring affordability for citizens and positive economic impacts for the city.

Table 1 summarises the global trends for each key performance indicator (KPI) analysed by the project in the *Barcelona case study assessment report (Task 3.2., Nov. 2015),* using statistics from the city and wider region depending on data availability. In red are the indicators in which Barcelona records a negative trend, green for positive; overall Barcelona's trends are all in line with a post-carbon city trend. Negative developments have been caused by external economic shocks rather than a lack of policy action.

Table 1: Summary of KPI's global trends

Dimension	Sub-dimension	INDICATOR	Year	Trend
SOCIAL	Social Inclusion	Variation rate of unemployment level by gender	2003-2015	↗
		Variation rate of poverty level	2004-2014	↗
		Variation rate of tertiary education level by gender	2003-2013	↗
		Variation rate of average life expectancy	2003-2012	↗
	Public services and Infrastructures	Variation rate of green space availability	2004-2013	↗
	Governance effectiveness	Existence of monitoring system for emissions reductions	N/A	yes
ENVIRONMENT AND CLIMATE	Biodiversity	Variation rate of ecosystem protected areas	2009-2013	n/a
	Energy	Energy intensity variation rate	2003- 2012	↘
		Variation rate of energy consumption by sectors	2003- 2012	↘
	Climate and Air Quality	Variation rate of carbon emissions intensity	2003- 2012	↘
		Variation rate of carbon emissions by sector	2003-2012	↘
		Exceedance rate of air quality limit values	2003, 2012	↘
	Transport and mobility	Variation share of sustainable transportation	2004 – 2014	↗
	Waste	Variation rate of urban waste generation	2003- 2014	↘
		Variation rate of urban waste recovery	2006- 2014	↘
	Water	Water losses variation rate	2011-2014	↘
	Buildings and Land Use	Energy-efficient buildings variation rate	2013	n/a
		Urban building density variation rate	2001-2011	↘
ECONOMY	Sustainable economic growth	Level of wealth variation rate	2003-2012	↗
		Variation rate of GDP by sectors	2003-2014	
		Employment by sectors variation rate	2003-2014	
		Business survival variation rate	2009-2014	↘
	Public Finances	Budget deficit variation rate	2003-2015	↘

Dimension	Sub-dimension	INDICATOR	Year	Trend
		Indebtedness level variation rate	2003-2015	↘
	R & I dynamics	R&D intensity variation rate	2004-2012	↗

Source: Own estimations.

The municipality of Barcelona has seen a slight fall in population from 1970 to the year 2000, from 1.75 million inhabitants to 1.5 million inhabitants. The population has since increased due to the revalorisation of the centre of the town and is today just over 1.6 million. The metropolitan area has increased strongly in population from 2.74 million inhabitants in 1970 to 3.2 million. The province of Barcelona has seen an increase from 3.9 million to 5.5 million inhabitants. The influx of young immigrants from other parts of Spain and abroad has helped Barcelona to mitigate the impact of the ageing population.

The creation of the AMB as an entity to help develop the city in an integrated and coherent fashion is helping it to develop an efficient transport sector, and this is reflected in a growing use of public transport. Efforts to facilitate cycling and walking are clearly paying off, according to census results.

Barcelona is at the forefront of the Smart City movement and is aiming to retain its position, despite the financial crisis and the difficulties this has created for new investment. The city is still vibrant in initiatives and seems poised to regain any lost ground.

Sustainability strategies from transport to green space protection and waste and water management are being implemented.

The city is also trying to find a balance between the need to maintain it as a tourist centre, while keeping its local character. The modernisation of the city has not changed the strategy of the authorities to retain the local markets and the characters of the city districts with their 'town centre'. There will be a need to balance the pressures created by the tourist and expat community, and the protection of the patrimony and local social structures, which in turn make the city attractive to tourists and investors too.

From the point of view of carbon emissions, Barcelona has several strategies that seem to be impacting on carbon emissions. Emissions intensity and total emissions have been falling, and despite the impact of the financial crisis there is some indication that GDP growth and emissions have been decoupled to some extent as energy intensity was also falling before the crisis hit. The fall in carbon emission per unit of GDP fell by nearly 30% in the last decade.

In the residential sector the advance has been modest at this stage, as the energy efficiency certification of buildings was introduced only recently and there is this little information that can be extracted from the registration process, except that the energy certification of buildings is taking place rapidly and the database of the municipality has issued 150,000 permits.

The city of Barcelona seems to be solidly anchored on a post-carbon path, driven by its objective to remain at the forefront of the smart city movement. This means that Barcelona can be seen as an example of progress. The city needs to pay particular attention to the risk of poverty and social exclusion. Barcelona may recover from the crisis, but some groups in society may well fall into long-term unemployment and poverty.

Barcelona is leading on the path to sustainable economic growth. Two aspects may require the attention of the city authorities. First is the need to address the challenges of an increased share of the population at risk of exclusion and poverty. The city has focused strongly on the tourism and business attractiveness and is at the forefront of actions in the area of technology and environment. The risk may be a class of marginalised citizens not able to benefit from the advanced city features.

Barcelona is crossing the threshold from being a testing ground for technologies to being a large-scale user of these technologies. For this, a stronger role for the AMB as coordinating body for the city may be needed. The movement is there, the recommendation is to continue ahead.

The growing level of municipal indebtedness will require the city to explore new financial models for public procurement and public services, seeking better cost-recovery mechanisms while ensuring affordability for citizens and positive economic impacts for the city.

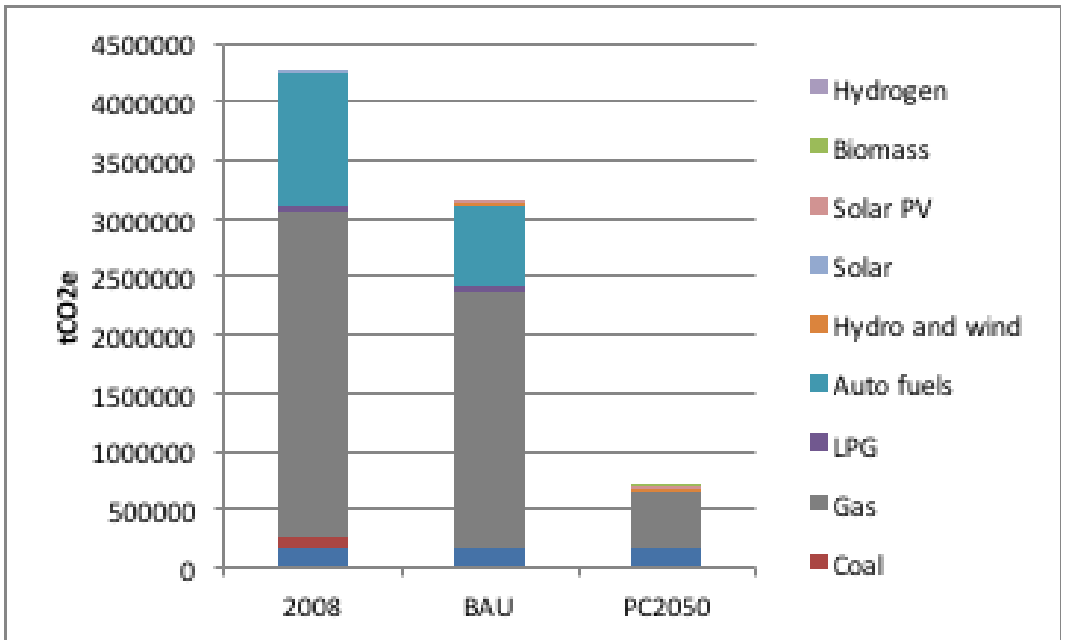
INSIGHTS FROM THE GAP ANALYSIS FOR THE CITY

Despite the advances of the city, there are difficult challenges ahead. The 'GAP' to a post-carbon city is large and emissions need to be addressed more vigorously, the business as usual estimations show a very large gap between the objectives and final emissions (see the Barcelona initial assessment D 3.2). The results below on the gap analysis and partially the text are extracted from the quantification of the case study post-carbon city scenarios, as well as the BAU scenarios (D 5.2).

The GHG emissions drop from energy sources required (Figure 1) for a post-carbon 2050 city (PC2050) is much steeper that the outcome under BAU (based on a continuation of the present trends). This section presents a summary of the figures and results from the sustainability impacts of post-carbon cities in WP5. The majority of emissions in 2008 and BAU are clearly the result of the use of natural gas in heating and electricity production. In BAU the total GHG emissions are reduced by 27% compared to 2008. Emissions from transport are reduced by 40%. It should be noted that these figures do not include emissions from waste and the quantities may be higher in comparison to local estimates due to lifecycle assessment emission factors being used. In the PC2050 scenario total emissions are reduced by 84%, but there is still some use of gas, which accounts for 70.5% of emissions (even though gas use is reduced by almost 91% compared to 2008).

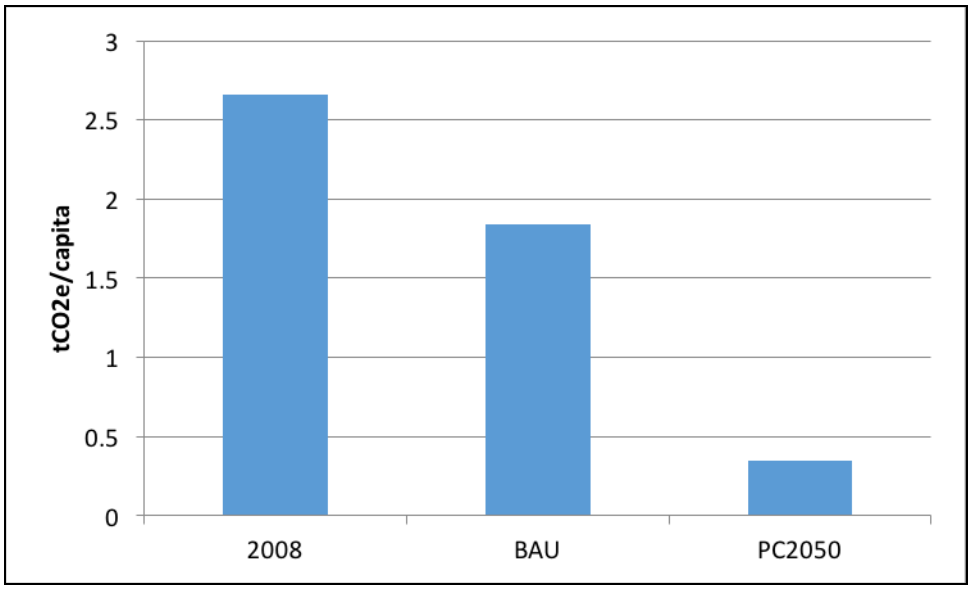
Figure 2 compares the GHG emissions per capita for 2008 and the BAU and PC2050 scenarios. It highlights a considerable drop required in per capita emissions to achieve PC2050 to 350kg compared to over 2.5 tonnes in 2008. Under BAU emissions also drop to 1.84 tCO2e/capita.

Figure 1: GHG emissions associated with energy sources for Barcelona for 2008, BAU and PC2050



Source: POCACITO quantification of case study cities D 5.2.

Figure 2: GHG emissions per capita for Barcelona Municipality for 2005, BAU and PC2050

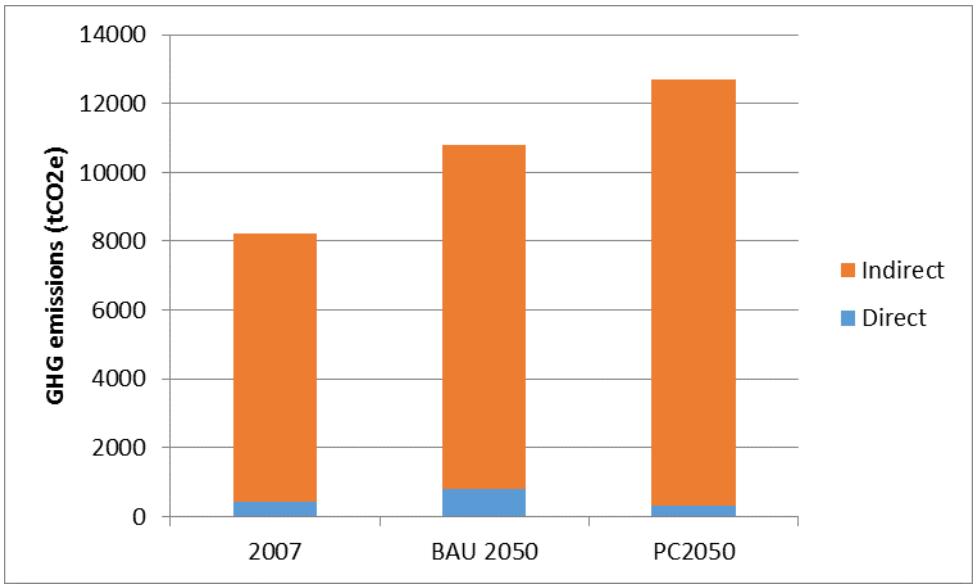


Source: POCACITO quantification of case study cities D 5.2.

Beyond that, the reducing emissions not generated within the city itself, but caused by its activities, will need to be addressed. Barcelona is a large tourist centre, with intensive air traffic and maritime activity. Tourism and environmental sustainability will be a challenge.

In fact, the challenge of the indirect emissions is considerable, because the projections show that even if the city reduces direct emissions successfully under a post-carbon city scenario, this is at the cost of indirect emission increases. This is why a city strategy cannot be successful on its own if global emissions are to be reduced. The sustainability impact analysis shows that while there is a reduction in local emissions from transport and electricity, other goods and services cause increases in consumption, linked to strong growth in GDP, leading to a higher level of emissions than today.

Figure 3: Direct and indirect GHG emissions for Barcelona for 2007, BAU and PC2050



Source: POCACITO quantification of case study cities D 5.2.

SOCIO-ECONOMIC ASSESSMENT

INVESTMENT COSTS

The investment costs for renewable energy and building renovations, over the period 2018 to 2015 for each scenario are shown in the table below The total costs of PC2050 are €3.6 million compared to €1.3 million for BAU. However, the table also shows that these costs would represent only 0.31% of accumulated GDP (from 2018 to 2050) for the PC2050 scenario.

Table 2: Investment costs for BAU and PC2050 Scenarios

Energy	**MEUR (2016)**
BAU	851
PC2050	2,120
Total costs for fossil free energy	2,599
Building renovations	
BAU	3,617

PC2050	8,441
Total costs (Energy and buildings)	
BAU	4 469
PC2050	10 562
Costs as % of accumulated GDP (2018 to 2050)	
BAU	0.15%
PC2050	0.31%

Source: POCACITO quantification of case study cities D 5.2.

This translates into the following discounted costs as shown in the next table at various discounted rates from 2018 to 2050.

Table 3: Net costs for scenarios investments at different discount rates (MEUR)

DISCOUNT RATE	1%	3%	5%
BAU costs (NPV)	3775	2792	2792
PC2050 Costs (NPV)	8921	6597	5097

Source: POCACITO quantification of case study cities D 5.2.

COSTS/BENEFIT ANALYSIS

In this section we examine the following cost benefits: cost reduction in mortalities due to reduced air pollution, additional jobs due to renewable energy and renovation of buildings and a qualitative examination of reduced energy costs in PC2050.

REDUCTION IN MORTALITIES DUE TO REDUCED AIR POLLUTION

The current costs of air pollution in Barcelona are estimated at EUR 1,882 billion/year based on the 2010 cost of 2.8% of GDP for Spain provided by WHO (WHO Regional Office for Europe and OECD, 2015). In order to estimate the potential benefits of the scenarios compared to today's costs, the cost due to air pollution of the scenarios was subtracted from the cost due to air pollution at the 2010 GDP percentage. This was performed for each year from 2018 to 2050. In this way the benefit of the scenario can be seen as the savings achieved compared to the 2010 cost rate. The cost of the scenarios is based on a linear change from 2018 to the 2050 scenario cost percentage. This is calculated as a ratio of fossil fuels and biomass combusted in the scenarios compared to the current use in GWh.

The net of benefits of BAU and PC2050 at different discount rates are shown in Table 4. The table shows the benefit of the change in mortality due to the change in air pollution. In addition to BAU and PC2050, it also compares the benefits that would be obtained if there was a linear progression from 2018 to no air pollution in 2050.

Table 4: Accumulated cost savings (2018-2050) due to reduced mortality in the scenarios, and for no air pollution by 2050 (EUR millions NPV)

	DISCOUNT RATE		
	0.8%	1.0%	1.2%
BAU	20 037	19 178	18 362
PC2050	37 712	36 063	34 497
No air pollution	38 533	36 881	35 311

INCREASED EMPLOYMENT

The potential for increased employment due to the use of renewable energy and building innovation is summarised in Table 5. Potential jobs for renewable energy are modest with 310 ongoing jobs from operation and maintenance, but contribute to nearly 24,000 from manufacturing through to installation. The number of jobs created from the renovation of buildings is significant at 82,002. It should be noted that the jobs are for the entire supply chain, as well as indirect effects and are based on a figure of 12 jobs per million euro spent. This should be seen as the total number of jobs to 2050, which may not be ongoing in all cases.

Table 5: Benefits of PC2050 scenario compared to BAU for Barcelona

Additional PC2050 Jobs	MCI	O&M
Renewable energy	23665	310
Building renovation	82002	

REDUCTION IN ENERGY COSTS

Due to limitations in data availability and the scope of the project the energy costs of the scenarios could not be compared with the current costs. It is possible to provide a semi-quantitative and qualitative indication of the costs, however.

PC2050 can be expected to have lower costs than BAU as a result of increased energy efficiency meaning that energy consumption is 7.2% lower. Currently (2013) Barcelona has only 3.1% renewables in its energy mix and this is expected to increase to 16.7% in BAU and 58.3% in PC2050. Hence there is the potential for much greater energy security and lower risks due to the volatility of fossil fuel prices.

In summary, there is potential for 7.2% reduction of costs in PC2050 due to reduced energy consumption and a further reduction related to the 41.6% additional renewable energy.

GAPS AND RISKS

The most prominent gaps for Barcelona under the current PC2050 scenario are as follows:

Energy and environment

There is an assumed continued reliance on nuclear power to supply the majority of the electricity. This is due to the challenges of providing enough renewable energy at the city level, but also because

nuclear is already a low-carbon option. However, due to the shortfall in developing significant quantities of renewable energy there is a need for a high input of natural gas, which is responsible for the majority of GHG emissions. The current trends for the self-provision of renewable energy are not big enough to make much impact under BAU.

The projected per capita GHG emissions for PC2050 are among the lowest of the case study cities, at only 340 kgCO2e/capita, but with total emissions of almost 700,000 tonnes it still falls short of absolute zero carbon. This is mainly due to the reliance on gas for some heating and electricity generation. There is still a major shortfall seen in the provision of sufficient quantities of renewable energy (due primarily to a lack of consistent and robust actions and milestones from the scenario workshops).

In order to close this gap there is a need to provide an additional 1102 GWh of energy from renewable energy. This is slightly more than the 953 GWh that were supplied in 2008 from renewable energy.

The data availability to assess biodiversity was low but this was not addressed in the PC2050 vision or actions and hence should be considered in the strategic paper. Although waste reduction was not addressed in the PC2050 vision, there was an ambitious target for waste recovery and recycling. This should be further supported in the strategic paper, along with actions for the circular economy (see below).

Socio-economic

The business survival rate has decreased significantly from 90% to 69% (2008 to 2010), which is of concern, but there are not enough data points to indicate a trend or facilitate modelling to 2050. This is also exacerbated by the fact that Spain was particularly affected by the financial crisis, which is not likely to affect circumstances by 2050.

Unemployment increased dramatically from 60% in 2002 to 23.7% in 2012, leading to some concern, but again it is impossible to project to 2050 from these figures. This is also true for the poverty level, which also increased from 2.4% to 17.7% during 2004 to 2013.

There is some inequality in the tertiary education rates, which are greater for males at 37.7% than for females at 31.9% in 2013. But both have increased from around 27% in 2003.

Urban sprawl

Although the population of Barcelona Province is projected to decrease under BAU by 281,700 or 5.3 %, the use of land for urban development (sprawl) will still increase by 161.0 km² or 19.9 % on the at the expense of non-urban land.

We have assumed within the PC2050 that densification will occur and that there will be no urban sprawl. However, the BAU scenario highlights the potential for significant urban sprawl, which needs addressing in the strategic paper. The paper should therefore address two aspects. First, it should address the potential for an increase in population under PC2050 within the municipality and plan for densification. However, there is also a role for Barcelona Municipality to encourage further movement of the Province population to the municipality. This is in order to reduce the risk of further

urban sprawl but also to capitalise on the additional sustainability benefits of densification, such as improved energy efficiency and reduced transport infrastructure and public services.

Circular economy and lifestyles

The potential for improvements in the impact of consumption are currently not well addressed in the PC2050 scenario. Options include increasing the facilities for reuse (e.g. through provision of locations to leave unwanted good for reuse) and repair (such as repair cafes), but also to support businesses and innovation in this area.

STAKEHOLDER CONSULTATION WORK

Three workshops have been held, structured closely to the methodology presented in the training workshop at the partner meeting in Berlin on September 9 and resumed in the deliverable T4.2 *Case study workshop guidelines*. The workshops developed visions of the city and backcasting exercises, initially to identify the long-term interests of the city. Workshop vision and backcasting exercises were repeated twice with different stakeholders and the following sections present the results of the meetings. First, the main objectives for city and concerns are presented followed by the actions over time that resulted from the backcasting.

THE 2050 POST-CARBON VISION FOR BARCELONA

The actual vision of the city is relatively conservative, since all stakeholders wanted to see the city largely preserved there was little discussion on the peripheral areas of the town and the focus was mainly on preserving the town's character. Notable changes proposed were the practical elimination of private transport in the city, the increase in communal spaces and the creation of functional neighbourhoods avoiding the separation of residential, commercial and working areas. The main wishes centred on having not only a clean and sustainable city, but a better educated and a more cohesive society. The concept of mobility was discussed, where the town focuses more on improving the mobility of citizens in a more social sense, reducing the need for transport, but rather facilitating the flow of people and avoiding transport-based social exclusion due to distance (reduced in functional areas). In other words, the 'need' to use private or public transport methods to move around the city should not be a 'necessity' for work, shopping, education, etc.

The natural areas should also be more integrated into the city, more in tune with the city, which probably also opens up the possibility of large experimentation on the outskirts of the town. The city should have a full circular economy, eliminating waste and a different way of functioning in terms of taxation and income generation.

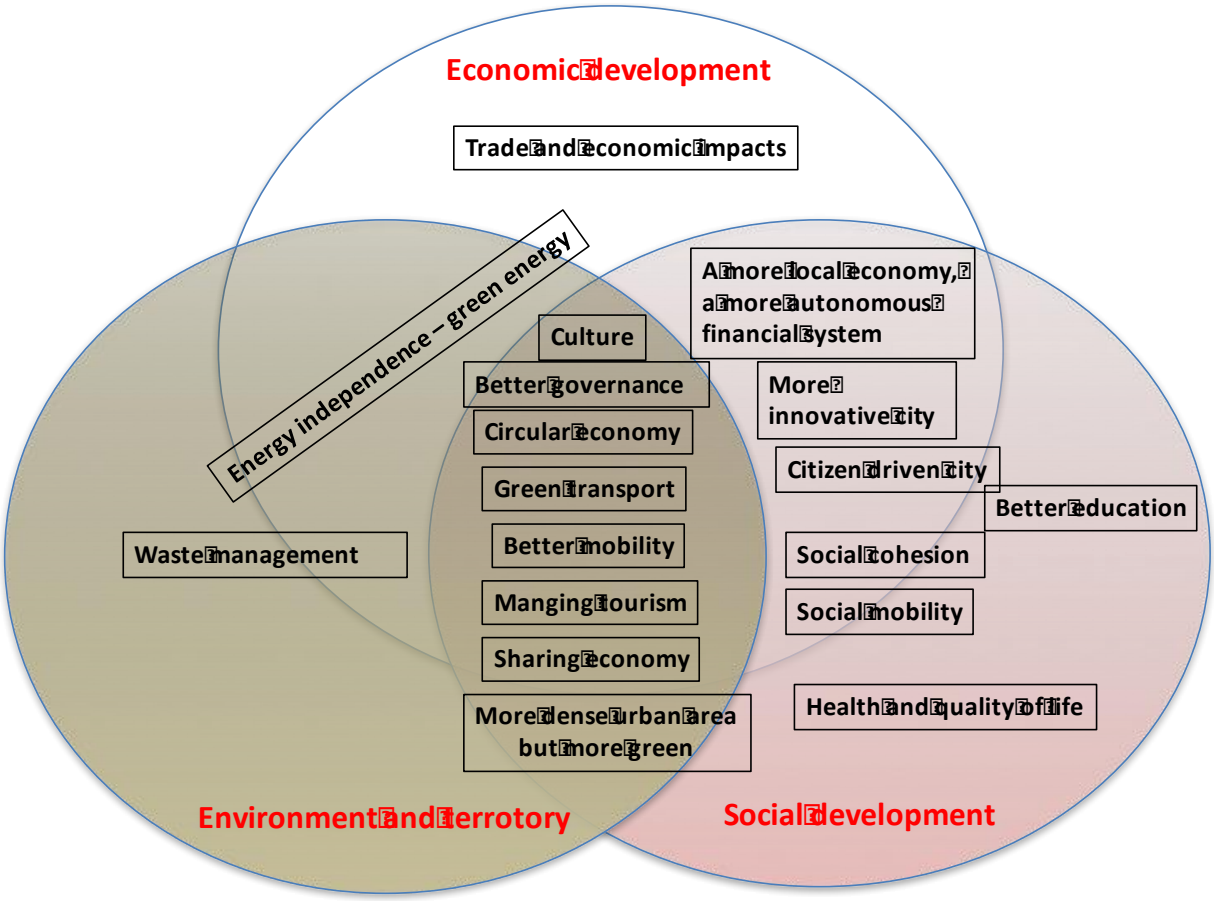
MAPPING THE CONCERNS

The discussion produced first mind maps identifying areas to address was used in the meetings. Chart 1 below summarises visually the main areas of discussion for the vision. It presents the key issues to be addressed clustered into three areas: economic development, territorial planning and social

development. The challenges and objectives were then debated along these priorities to end with a list of concerns which guided the development of actions and milestones.

The results emerged from two rounds of workshops visioning, which then were used for the backcasting.

Chart 1. Areas identified and overlapping sectors



MAJOR CRITICAL ISSUES IDENTIFIED IN THE VISIONING

The discussion highlighted the main critical issues for the city of Barcelona:

- *Better policy of planning for the metropolitan area:* coherent and integrated coordination of the sources of knowledge and proper civic managements.
- *A city that integrates in all products and services the environmental and social costs, creating a sustainable and healthy city (air, water quality, green spaces, healthier lifestyle) with and circular economy.*
- *A more resilient city:* more microgrids, a better use of local resources, smaller functional units (neighbourhood services, shops, supermarket).
- *Tourism management*: eight million tourists each year in a municipality of 1.5 million inhabitants leads to native depopulation and economic exclusion in the city centre. This affects the quality of life in the most central neighbourhoods and engenders a new economic and social dynamic that tends to exclude the local population. The preservation of traditional local markets (street markets) needs to be a priority and particular attention should be paid

to the effects of tourism on these realities. Tourism is an extremely important resource for the city but in order to reconcile it more with the local population part of the resources derived from tourist activities should be visibly deployed in favour of the residents. A balance between tourism and the quality of life of the local population needs to be sought.

- *Public space management*: closely linked to the tourism point is the issue regarding the valorisation for residents of public spaces (including tourist areas). Barcelona's citizens need to feel ownership of the city's public spaces; in order to do that the characteristic, traditional and local features of the city need to preserved in the development of new initiatives.
- *Renewable energy self-sufficiency*. This requires clarifying which energy models need to be put in place and which are the barriers (regulatory, financial, technological etc.) impeding their implementation. What is the economic impact of developing smart grids projects and of pursuing energy self-sufficiency?
- Reliable and consistent *tools to support public policy need to be developed*. The effectiveness of decisions taken based upon research report findings or cost-benefit analyses of questionable accuracy was often mentioned; there is need for new tools able to evaluate in a rigorous way both private and public interests.
- Effective urban planning needs to be supported by stable and *autonomous local financing*. In this view, the reform of legal barriers that impede appropriate self-financing need to be reformed.
- *Public participation:* A more informed citizenship that participates in decision-making, supported by the development of *social networks*.
- *More egalitarian and cohesive city.*
- A city in tune and *integrated more with nature*.
- *Education*: not only standard and business oriented, but also social.
- *Innovation is needed* – research focus of the city for the city.
- *Public transport* needs to efficient, accessible and clean. The stakeholders went further by not only expanding public transport, but by demanding a new approach based on the concept of 'mobility' rather than transport. Based on a collaborative society with more common spaces and a different use of collective space, the need for transportation can be reduced.
- *The city needs to increase the intensity of the use of its space,* increasing density and reducing urban sprawl.
- *Sharing economy, rather than an owner economy.*

THE DETERMINATION OF MILESTIONES AND ACTIONS

Participants had to transform their visions, objectives and problems into milestones for the city and then identify actions to make them reality in a clear timeline.

Many of the milestones and actions were considered necessary in the short term. Many practical barriers require removing to be able to achieve longer-term goals. Table 6, below, shows the time on the left side to achieve specific milestones. Those for 2050 are generally final full changes that require constant adaptation from now on. The two right columns show what specific actions need to be undertaken to achieve the milestone and when this change could be 'realistically' implemented.

The table is divided in colour-coded categories of objectives to achieve:

a) Local transversal coordinated public management
b) High level of knowledge, awareness and information
c) Implementing green and sustainable citizen-driven growth model
d) Developing green energy system and a clean low carbon circular economy
e) A fully decarbonised transport system and better mobility
f) Energy efficiency in buildings with 0 or negative emissions
g) Establishing the enabling framework conditions for post-carbon cities to flourish

Table 6: The when and the how of long-term objectives – milestones and actions

Time	Milestones	Actions to achieve milestones	Time action
Local transversal coordinated public management			
2017	Reform of management	Better impact analysis rules by the local authorities of projects, better coordination between services	**2016-17**
2018	Create transversal platforms	Coordinate all-city activities	**2020 onwards**
2018	Concentrate coordination powers in the AMB authority	Law reforming the responsibilities of the Barcelona Metropolitan area authorities (AMB)	**2018**
2020	Create a bigger metropolis vision	Create a metropolis vision with citizens to establish joint management structures	**2017-2020**
2035	Fully integrated territorial/urban/metro-politan management	Laws reforming the responsibilities all area authorities beyond 2020 milestone	**2018 and subsequent rulings**
High level of knowledge, awareness and information			
2018	Launch demographic needs studies	Understand demographic needs better to plan long term	**Now onwards**
2017	Better information loop and feedback	Create a flow of information to citizens and integrated feedback mechanism (use ICT). Real time, more personal	**2017 onwards**
2017	Clear information on the local climate change	More public awareness of the situation	**2017**

	impacts		**onwards**
2025	Young generations with better civic education	Education reform	**2017**
Implementing a green and sustainable citizen driven growth model			
2018	Monetised 'good deeds'	Introduce financial recognition system for work beneficial to the city and its citizens	**2018 onwards**
2020	A better work-life balance	A plan for sustainable mobility and teleworking that all businesses have to develop	**2020**
2023	Sharing economy	Legislate on sharing and ownership	**2025 onwards**
2020	Plan to re-sanitise and reuse commercial and residential areas	Reuse of abandoned spaces, incentivise the change of use in the future of residential and commercial areas towards a more sharing and mixed society. Develop necessary actions and regulatory changes with citizen involvement.	**process**
2023	Citizen involvement stronger and incentivised (e.g. through financial mechanisms)	Introduce new systems for citizen participation, ensure that citizens understand repercussions and costs of changes and demands	**2020**
2050	A city with shared spaces, social, work, activities, cultural areas, commerce, etc.	Design of integrated neighbourhoods: Different city management, planning, architectural structures, etc. with citizen involvement	**2020 onwards**
2040	Urban vertical covered greenhouses	Developing vertical farming in cities, new technologies	**From now onwards**
2050	Deeply re-naturalised city	Natural space needs to be part of the fabric of the city	**Constant change**
2050	Having a large SME presence in the city – proximity shops and services preserved	Increase training for businesses - entrepreneurship Maintain and expand local services Legal and fiscal reforms to facilitate the creation of SMEs	**Constant effort** **2020**

2050	Health system guaranteed for all	Reform health system	**No specific date**
Developing green energy system and a clean low carbon circular economy			
2025	Smart Grid	Legal reforms to allow RES integration and independent entities Smart grid with 80% renewables	**2018** **2040**
2025	All products designed to be recycled or for sustainable destruction	New EU rules on product design and recycling/degradation	**2020**
2025	All waste treated and recycled	New rules on waste and proper plans	**2020**
2050	Full circular economy	Designing full circular economy systems, introduce right incentives and mechanisms (so that falling emissions are not due to shifting emissions to outside the city)	**From now onwards, constant changes**
A fully decarbonised transport system and better mobility			
2017	Public transport is not only designed radially but in the form of a net	Reform of transport planning Coherence between national, regional and urban area transport authorities; infrastructure planning needs to be integrated	**2015-2016**
2020	Reduce emissions from shipping in the port – ships no longer with motors on	Change rules and build energy connections	**2016-2020**
2030	Achieving 'optimal' public transport	Fully electric with a transition period supported by fiscal incentives	**Starting now**
2035	No more fossil fuel transport in city	Law to ban fossil fuel transport and phasing in scheme	**2025**
2035	All private transport driverless	Phasing in driverless transport over 10 years	**2025**
2050	A city with mobility at its core rather than	Mobility is not only a question of transport, but a question of easy access to city services. Better, more liveable districts with accessible	**2020**

	transport	shops and services enhance mobility without need of transport systems. There is a need to design another structure for the city.	
Energy efficiency in buildings with 0 or negative emissions			
2030	**All public** buildings renovated and energy efficient		**Now onwards**
2030	**75% of all** buildings renovated and energy efficient	*Fiscal and legal reforms* to incentivise to building renovation, intermediate milestone.	**2022**
2045	**All** buildings renovated and energy efficient	*Fiscal and legal reforms* to incentivise building renovation	**2022**
Establishing an enabling framework for post-carbon cities to flourish			
2022	EU Fiscal decentralisation- division of powers directive	Allocate right competences to the right level of governance to ensure solutions are optimal and effective	**2018**
2030	Reach the 3% investment in R&D for region	Incentivise R&D investment with public funds and facilitate private investment	**From now onwards**
2050	A high 'happiness' index result	Ultimately a city is for citizens, who have to find a way to fulfil their lives in terms of interactions and experience, and should be motivated to be part of the city and give to it	**Constant aim**

Some interesting aspects were clear in the workshop. First, that the participants see that much of what they expect from the future of Barcelona can be achieved in the short and medium term. Second, that all the bases have to be set in the near future. 2050 is much nearer than expected.

The workshop clarified the interrelationship between separate parts of the city. Participants are also aware that reductions in emissions cannot be achieved by increased emissions outside. There was a concern that trade and air transport are increasing external emissions.

STRATEGIC RECOMMENDATIONS

Crucial to achieving many of the milestones is a reform of competences and municipalities. The municipal borders are based on the historical city limits and surrounding villages; today the urban area cannot be run under the present multi-municipal fragmentation of powers. There is a need to

have an entity covering the metropolitan area with the appropriate coordination powers. The institution exists, but it lacks the necessary responsibilities and structures, the Area Metropolitana de Barcelona (AMB).

Cooperation with regional authorities needs to be revisited, as many of the emissions and pollution of the city are indirect. Lower environmental impact in the city does not mean lower global impact as projections have shown in the POCACITO impact analysis. A new rational division of powers based on functional subsidiarity is required. This is a problem in all EU member states and may need a decentralisation directive.

A strong concern is the loss of character of the city and the growing disengagement of citizens. A common feeling among participants is that the city needs to find a better balance in catering to citizens and its economic goals by promoting tourism and industry. It seems that the pressure to increase foreign revenue may be causing negative effects – even on the tourism sector itself.
The strategy is presented in terms of milestones and actions. The main concern is that some key needs require political action at levels above the city competencies.

ASSESSMENT OF NEEDS

Challenges cannot be achieved by the actions of city authorities alone. Many enabling conditions have to be created by national and EU rules and regulations, as well as access to financial tools adapted to their needs.

What can the city do?

- Better planning involving stakeholders. This requires realistic scenario building by making stakeholders follow the steps. The POCACITO backcasting approach is such a tool, helping stakeholders consider the stages and understand the needs. A challenge is how to involve as many stakeholders as possible in such a complex approach.
- Integrate better the administration and create functional regional areas to manage services.
- Improve the information to citizens
- Improve social integration with a rational use of common spaces

What should the national authorities do?

- Reform the division of powers, taking into account the need to have an effective functional power distribution, in line with climate, energy, environmental and social needs
- Revisit fiscal decentralisation rules, so that also here the subsidiarity principle prevails, helping local authorities to handle local financial needs
- Clear coordination of national-regional transport systems
- Improve the education system
- Promote R&D and a more advanced knowledge economy

What should the EU do?

- Strict new regulations on car standards leading to 0 emissions and driverless cars

- EU directive on division of powers to promote a better more functional division based on actual needs on the ground
- Build regulation improvements to help increase the adoption of energy efficiency solutions
- Ensure that national energy rules stay in line with the renewable energy targets and help decarbonisation
- Offer support to regions through better exchanges of knowledge and support tools

IMPACT OF THE PROPOSED ACTIONS BY STAKEHOLDERS ON LONG-TERM CITY TRENDS

This section presents an analysis that interprets the results of the workshop's vision and backcasting, introducing the measures stakeholders have proposed. The business as usual (BAU) scenario is primarily developed from a continuation of current trends, with consideration of current projects. The analysis and text is based on the sustainability analysis in D 5.2. The data analysis suffered from limited data, as well as the fact that some data is often present in non-comparable levels of territorial disaggregation, i.e. either region, district, municipality or metropolitan area.

The current energy use trends for Barcelona were used with caution because they closely follow potential fallout from the financial crisis. Energy use was actually growing until 2006. After 2008 the GDP dropped. Within the municipality the energy growth is consistent with the population growth from 2001 until 2006. Data from Oxford Economics shows that GDP returns to steady growth in 2014. Most of the decline comes in the transport and industry sectors, which is probably due to the financial crisis. This is in line with the Province as well. This could also suggest that people travelled less to the city from the provinces.[1]

GDP by sector shows that the service industry has grown by almost 10 percentage points, while industry has declined. From this we deduce that with a recovering GDP, energy consumption could increase again. The transport share could also increase to a level similar to that of the financial crisis.

Due to a lack of data we therefore suggest that BAU energy consumption is similar to 2005, with a greater share covered by the service sector. The service sector has continued to increase GDP while decreasing energy use. At the Province level the population does not grow any further according to projections from Oxford Economics. According to the projections in EU Energy Trends 2050 (Capros, 2014) the growth in the final energy demand for Spain is in line with population growth, at 14.6% and 14.5% respectively. According to the Barcelona Energy and Climate Plan the electricity share has increased from 37,2% to 44.3%, and we also expect a continuation of this electrification trend.

We therefore assume that the:

- Service sector continues to grow to 2050 but improves efficiency - therefore similar energy in total
- Industry sector recovers to 2005 levels with slightly increased efficiency 5%.

[1] http://www.diba.cat/documents/471041/24663576/emissions+in+Barcelona_july+14.pdf/34110b21-ca61-4da6-acc2-d4f83695fc2a

- Residential sectors' increase in electrification cancels out efficiency increases, thus remaining fairly similar.

The next section summarises the result of the analysis on city trends and the need to further refine the milestones and actions to fit the trend to the objectives.

SUMMARY OF THE RESULTS OF THE TREND ANALYSIS

Table 7: Semi quantitative assessment of the POCACITO KPI's under BAU and PC2050 for Barcelona

	SUB-DIMENSION	INDICATOR	UNIT/INFO	Quantity	Trend	BAU 2050	PC 2050
ENVIRONMENT	Biodiversity	Variation rate of ecosystem protected areas	Percentage	28% (2012)	No data on trend	N/a	N/a
	Energy	Energy intensity variation rate	toe/euro toe	(2003-2012) 28.47 to 23.83 1.6 Mtoe to 1.4 Mtoe	- 16.3%	+	++
		Variation rate of energy consumption by sectors	Percentage	From 2003 to 2012	Residential 2003 – 2012: - 2.4% Services 2003 – 2012: + 1.97% Industry 2003 – 2012: - 21.25% Transports 2003 – 2012: - 18.16%		
	Climate and Air Quality	Variation rate of carbon emissions intensity	ton CO_2/euro ton CO_2	(2003-2012) 84.77 to 60.95 4.72 to 3.69 MT	Decrease (-28.1%) -	+	++
		Carbon intensity per person	ton CO_2 eq. / capita	3.06 to 2.27	-25.9%	+	++
		Variation rate of carbon emissions by sector	ton CO_2	From 2003 to 2012	Residential: - 4,85% Services: - 1,86% Industry: - 16,78% Transports: - 18%	++	++

	SUB-DIMENSION	INDICATOR	UNIT/INFO	Quantity	Trend	BAU 2050	PC 2050
		Exceedance rate of air quality limit values	*Nº*	*19-2 (2003-2012), 5 in 2013*	*Annual variations, but still decrease?*	++	++
	Transport and mobility	Variation share of sustainable transportation	*Percentage*	From 2004 - 2014	*Public: 34.9% to 39.7%* *Private: 33.3% to 26.1%* *Walk and cycle: 31.7% to 34.1%*	*0*	++
	Waste (1)	Variation rate of urban waste generation	*kg/person/day 2003 to 2014*	*1.44-1.26 kg/person and day*	*1.44-1.26 kg/person and day*	++	+
		Variation rate of urban waste recovery	*Percentage*	*Waste to recycling :30.4%-36.11% (2006-2014)* *Organic waste amounts: 86914-122508 tonnes/year (2007-2012)*	*Waste to recycling :30.4%-36.11% (2006-2014)*	++	++
	Water	Water losses variation rate	*m^3/person/year*	*Data only provided in percent for a single year (17.9% in 2013)*	***Water use** reduced 2001 to 2014* *129.6 to 101.1 L/cap/day*	*N/a*	*N/a*
	Buildings and Land Use	Energy-efficient buildings variation rate	*Percentage*	*No data*	-	*N/a*	++
		Urban density variation rate	*Nº/km^2*	*No data*	-	*N/a*	*N/a*
ECONOMY	*Sustainable economic growth*	Level of wealth variation rate	*EUR/person*	*23,400-28,300 euro? (2001-2011; peak in 2007; purchasing power standard indicator)*	*Increase, sharp drop during crisis*	++	++
		Variation rate of GDP by sectors	*Percentage*	*Data missing*	*Data missing*	*N/a*	*N/a*
		Employment by sectors	*Percentage*	*Trend of decline in industry, construction and*		*N/a*	*N/a*

	SUB-DIMENSION	INDICATOR	UNIT/INFO	Quantity	Trend	BAU 2050	PC 2050
		variation rate		*services (2005-2012). Significant drop in primary section in 2008 which recovered over 2009-2012.*			
		Business survival variation rate	*Percentage*	*90%-69% (2008-2010)*	*Limited data points and only effects of financial crisis*	*N/a*	*N/a*
	Public Finances	Budget deficit variation rate	*Percentage of city's GDP*	*Data missing*	-	*N/a*	*N/a*
		Indebtedness level variation rate	*Percentage of city's GDP*	*1.19%-1.94% (2008-2010)*	-	*N/a*	*N/a*
	Research & Innovation dynamics	R&D intensity variation rate	*Percentage*	*1.33%-1.51% (2004-2012)*	*Increase, but possibly due to drop in GDP*	*N/a*	*N/a*
SOCIAL	*Social Inclusion*	Variation rate of unemployment level by gender	*Percentage*	*Diagram* *Men: 6.8%-23.7% (2001-2012)* *Women: 12%-22.5% (2001-2012)*	*Large increase in unemployment*	--	*N/a*
		Variation rate of poverty level	*Percentage*	*2.4%-17.7% (2004-2013; share of population in poverty risk)*	*Large increase*	--	*N/a*
		Variation rate of tertiary education level by gender	*Percentage*	*Male: 27.2%-37.7% (2003-2013)* *Female: 26.8%-31.9% (2003-2013)*	*Increase*	+	*N/a*
		Variation rate of average life expectancy	*Average Nº*	*80.0-82.2 (2003-2012)*	*Increase*	++	++
	Public services and Infrastructures	Variation rate of green space availability	*Percentage*	*65.5%-64.4%% (2003-2010)* *59.8%-62.1% (2011-2013; area changed)*	*No significant change?*	+	+
	Governance effectiveness	Existence of monitoring system for emissions	*Yes/No Description*	*Yes*	*Yes*	++	++

	SUB-DIMENSION	INDICATOR	UNIT/INFO	Quantity	Trend	BAU 2050	PC 2050
		reductions					

(1) The positive development in the area of waste is due to the rapid growth of recycling and composting. But this rapid growth is caused by the recent introduction of this action. Thus the growth rate may fall and the level of recycling and composting may ultimately fail to reach its potential by 2050.

LESSONS FROM THE ANALYSIS

The process proves that there is added-value when stakeholders are asked to think on the long-run, making them realise the following:

- It clarifies the who, when and what of actions
- It gives stakeholders an understanding of the needs of the city and the challenges
- 2050 is not a distant future; changes need to be undertaken today, bearing in mind the long-term objectives. It makes stakeholders understand that actions are needed now.
- It allows us to set a clear timetable and framework for long-term results and shows that many actions can be taken in the very short term.
- It increases the awareness that it is not enough to focus on the reduction of CO_2 emissions. Changing the way energy is produced and used has deep impacts on society. Societal change can be partially directed by linking decarbonisation to societal change.
- Stakeholders become aware that to preserve vital elements of the city in the long run there has to be a coherent approach and that short-term decisions can have long-term repercussions.
- It has made stakeholders who do not work in the energy and transport sector aware that it is in everybody's interest to shape the approach towards a post-carbon city.

This document cannot be used as a strategic recommendation for the city, for this the experimental nature of the exercise is too limited, but it can be the basis for a larger visioning and backcasting process that refines the analysis and approach presented in this document.

ANNEX. STAKEHOLDERS: BARCELONA

Surname	First Name	Organisation
Alcantud	Ana	Anteverti
Alguacil	Alan	Màster oficial en Planificació Territorial i Gestió Ambiental
Ariño	Josep	Transports Metropolitans de Barcelona (TMB)
Bayarri Valcárcel	Pascual	Consell Econòmic i Social de Barcelona (CESB)
Bohigas Segarra	Salvador	MSI (Manteniment Sostenible Integral)
Cuixart Tomos	Marta	*Estratègia i Cultura de Sostenibilitat. Ecologia Urbana,* Ajuntament de Barcelona
De Sarraga Mateo	Francesc	Oficina Tècnica de Canvi Climàtic i Sostenibilitat - Àrea de Territori i Sostenibilitat - Diputació de Barcelona
Devesa Vilalta	Miguel	Confederació de Comerç de Catalunya
Franquesa I Codinach	Teresa	Hàbitat Urbà
Fortuny	Jaume	Observatory of Globalisation, University of Barcelona
Giró	Joan	Col·legi d'Enginyers Tècnics i Pèrits de Telecomunicació de Catalunya
de Gispert Irigoyen	Gustavo	UPC-EPSEB
Junyent	Cristina	Fundació Ciència en Societat
Rodríguez Cantalapiedra	Inmaculada	Ampliació de Competències en Impacte Ambienta, Universitat Politècnica de Catalunya
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