European Commission

Why may replication (not) be happening

Recommendations on EU R&I and regulatory policies

EU Smart Cities Information System

EMPOWERING SMART SOLUTIONS FOR BETTER CITIES www.smartcities-infosystem.eu

Energy

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November 2018

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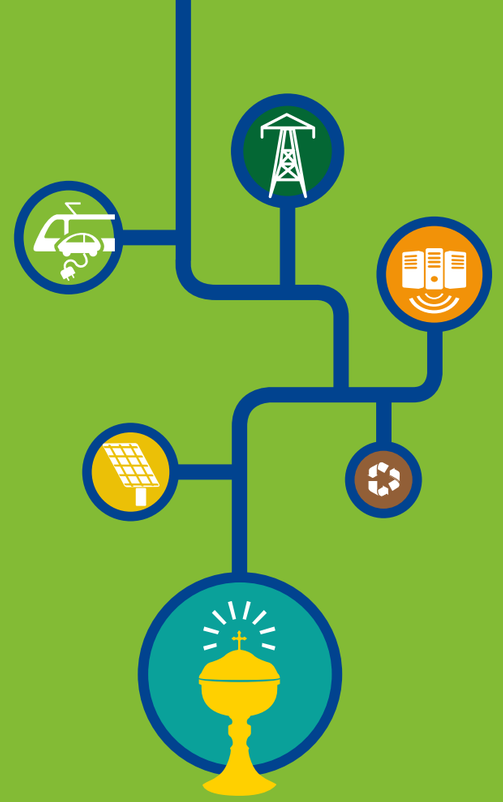


“Replication is like the quest for the Holy Grail: everyone is searching but no one seems to be able to find it.”

Björn Westling,
Work Package Leader/Deputy Site Manager
Gothenburg, IRIS project

INTRODUCTION

The present policy analysis investigates the reasons why replication of smart urban energy, mobility and ICT solutions for a clean energy future may be difficult. While evidence from smart city projects suggests that the devil is often in the details, it is at the same time possible to determine common mechanisms that appear to hamper replication.

The present paper identifies and discusses some general barriers and presents opportunities for overcoming them.

Further, more specific barriers and opportunities will be examined in follow-up publications with a view to formulating additional policy recommendations.

A TAXONOMY OF REPLICATION BARRIERS AND OPPORTUNITIES: FINDINGS FROM SMART CITY AND COMMUNITY PROJECTS

1. FROM REPLICATING TECHNOLOGIES TO INSPIRING SOLUTIONS

From a narrow techno-economic perspective, the aim of a smart city programme is to encourage the replication of technological solutions. However, we argue that a successful approach to replication needs to include further dimensions.

From the stakeholders' point of view, replicating a technology is of little interest unless it renders a needed service. This service may include 'soft' values like comfort, quality of life or responsible behaviour towards the environment: in the end, it needs to convince the end user to buy it. Therefore, key triggers for smart city solutions are to be found in its specific context and its motivators to make the end user adopt a given solution.

Smart city solutions are rarely a simple product or service. They often consist of complex urban interventions involving many different parties, each one with specific interests, agendas and capacities. Everything must be there, at the right place, in the right moment: the technologies, the business models, the favourable legal context, the governance structure, social acceptance, user motivation, capacities and knowledge, budgets, aligned agendas, etc.

If you have a complex product or solution, it is therefore an illusion to think that a technology or a business model can be easily replicated. Smart city solutions need a full, multi-aspectual[1] integration of all the constituting case-specific elements. This prerequisite makes it, at least initially, difficult to replicate a successful implementation from one local situation to another.

We find evidence for this proposition when we analyse the results of replication research within the Smart Cities and Communities (SCC) projects, see, for example, the outcomes of a survey performed by Triangulum in 2017 in Figure 1 next side.

1 From the methodological point of view, for structuring its research insights and outputs, the SCIS consortium uses a knowledge theory called multimodal (or multi-aspectual) system analysis. For an explanation of this reference framework, please refer to Vandevyvere, H. (2011) 'How to cut across the catchall? A philosophical-cultural framework for assessing sustainability' in: International Journal of Innovation and Sustainable Development, Vol. 5, No. 4, pp. 403-424.

In addition, the success of such an integrated project often depends on key actors, often individuals, with the specific vision and convincing power to pull the project. Trust building between stakeholders that are not accustomed to working together is equally essential in this process. Such human factors are difficult to control and thus add to the struggle of replicating success stories.

This brings us to pursue what Peter Rathje[2] calls **the city journey**: There must be a solid story with its champions, financiers, executors and users lined up for a particular endeavour.

2 SmartEnCity Network leader, ProjectZero Managing Director, Sønderborg (DK), SmartEnCity Project.

Which factors undermine the replication of existing smart city projects?

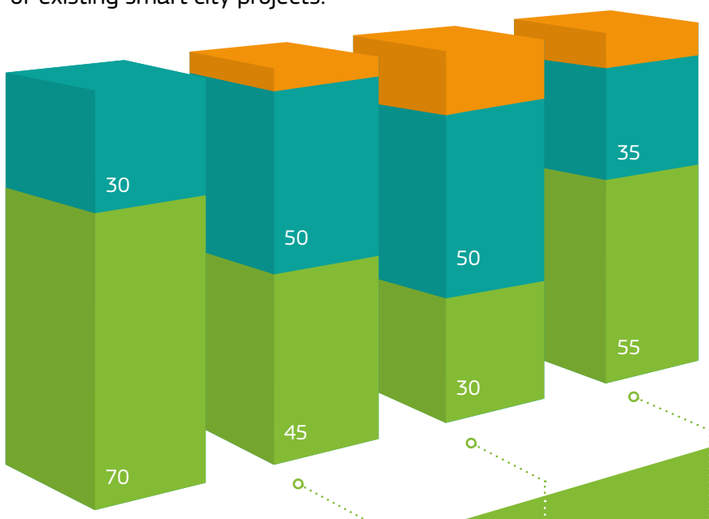


Figure 1: Extract from the Triangulum Replication Survey, 2017. 27 respondents from 18 cities filled in the survey across Europe.

Figure 2: Embarking on a city journey: brainstorming for a local, renewable energy future during the City-zen Roadshow, Roeselare (BE), April 2018 (http://www.cityzen-smartcity.eu/). The local context and stakeholder concerns define the settings from where possible solutions were co-created with all the urban stakeholders.

The city journey should preferably be underpinned by a long-term vision, designed as a shared roadmap to break through both time and human-related barriers.
The challenge of setting up such an integrated process is strongly linked to the context factors that are discussed in chapter 3.

2. BUSINESS AS USUAL IS TOO EASY

From many points of view, business as usual (BAU) is too easy and destroys the triggers for change. Although this may seem a trivial conclusion, there is ample evidence that the (high) daily workload structurally hampers the uptake of innovative practices. There is a strong path dependency for BAU.

SOME RESPONSIBLE FACTORS ARE:

- Companies are often under a strong pressure resulting from a short-term profit logic. Listed enterprises in particular feel the pressure of their shareholders for immediate financial returns. Guaranteed profit conflicts with high risk; so risks that can be avoided are discarded. Companies that are initially interested in an innovation trajectory are reported to drop off for such reasons. Similar conclusions can be drawn for innovation related transaction costs: Training staff, implementing new technologies and work schemes, etc. do not pay off especially when BAU yields a safe profit. Building and installation contractors in particular are in high demand, can choose their clients and continue to apply proven techniques without having an incentive for innovation. Financiers display strong risk aversion and wait for innovative markets to be fully established before stepping in, which leads to a vicious circle of non-action.
- Public authorities are administered through short-term political cycles, resulting in a pressure to provide achievements for the corresponding short term rather than to foster long-term structural change.
- The SCC projects under scope work towards the clean energy and climate action goals of the EU. However, fossil fuel prices remain too low, as does the carbon price. Experts agree upon the fact that in order to steer the economy into sustainable directions, a carbon price increase up to 100 Euros per ton and beyond is needed[3]. By their nature, low carbon investments will strongly benefit from incentives for environmentally corrected pricing. Projects effectively report that fossil fuel prices are too low to make the business cases viable.
- Cities as well as other organisations need to break through their organisational silos and routines in order to evolve from traditional, incremental innovation to the disruptive type of innovation that is required for upscaling and speeding up the energy transition. Hereby, public-public collaboration may be a harder nut to crack than public-private collaboration. If an organisation wants to reinvent itself, it should moreover be able to do so at affordable cost and without flawing the operational efficiency.
- Smart city projects imply, in varying degrees, behavioural change. Asking people to adapt their behaviour may be one of the toughest challenges encountered. Without the proper framing strategies regarding change processes, motivating and moving end users beyond the group of early adopters may not succeed. A body of knowledge and practical experience regarding motivation, peer pressure, social norms, nudging, etc. has emerged and can be put to work for replication. This may be judged just as important as the transfer of knowledge regarding technologies or business models may.

3 http://pubdocs.worldbank.org/en/911381516303509498/2017-Shadow-Price-of-Carbon-Guidance-Note-FINAL-CLEARED.pdf; https://www.carbonpricingleadership.org/report-of-the-highlevel-commission-on-carbon-prices/

It is difficult to change deeply anchored routines and practices at micro level (the smart city project) if the steering parameters at macro level (the global economy, societal trends) work against it.

In terms of climate action and the low carbon transition, this leads to the dilemma ‘everyone together or no one’.

By consequence and if there is any chance, **particular and locally differentiated triggers** will be essential for overcoming these barriers. This may coincide with **windows of opportunity** appearing in a given context and triggering a project, for example, through the formation of a critical mass of actors.

3. THE “WE ARE UNIQUE” SYNDROME

With regard to smart city solutions, cities tend to - partly - reinvent the wheel because they start from the rationale that their local context and situation is unique, so their solution must be unique as well. From one perspective, this is true: the local context and process might be unique indeed, as argued above. However, from another perspective and when regarding the material business case, it may lead cities to acquiring the most expensive solution: the one that is tailor made and rolled out on a small scale. This has led a group of SCC projects to pursue grouped acquisition, based on common requirements that pave the way for standardised, yet sufficiently context-sensitive solutions.

Context matters, but not always. The contextual requirements described above seem to conflict with conclusions regarding the ‘we are unique’ syndrome. This is, however, not always the case: we suspect that the replication secret lies in the proper combination of context-specific measures on the one hand and uniformity for scaling-up on the other hand. The question is what should be considered as context specific and where can and should the local context be transcended?

4. FROM PAYBACK TIME TO SECONDARY BENEFITS AND WILLINGNESS TO PAY

From a financial point of view, energy and CO_2 measures are often judged against a narrow payback logic, without taking into account secondary benefits for society or the principle of willingness to pay.

For public authorities in particular, it would be beneficial to account financially for such benefits like reduced social and health expenditures. For societies as a whole, the benefits of a cleaner and safer environment, reduced fossil fuel dependency and energy poverty, local employment in the green economy and a higher quality of life for all citizens will amount to billions of Euros. Honouring this effect, however, requires accounting principles that break through the traditional competence and budgetary silos.

A simple but convincing example of this principle was used in the Oldham Warm Homes campaign, UK[4] . The savings in both energy bills and local welfare expenditures seemed to compensate energy retrofitting costs of poorly performing homes as residents felt much better and reported to be healthier in their renovated houses. Emergency hospital admissions dropped by 32% for a sample population in the neighbourhood. The number of mental health issues, which come at a cost of nearly 1000 Pounds per intervention, drastically reduced as well.

For economic actors, secondary benefits like increased productivity of employees or reduced costs for time lost in traffic jams may make a difference. In this way, the additional cost of a sustainable and healthy company building may be paid back in a matter of months, thanks to the decreased costs of sick leaves and productivity losses related to poor working environments. Such accounting of secondary benefits like improved health may well start to be included in official strategies and regulations, e.g. regarding energy retrofit of the building stock[5].

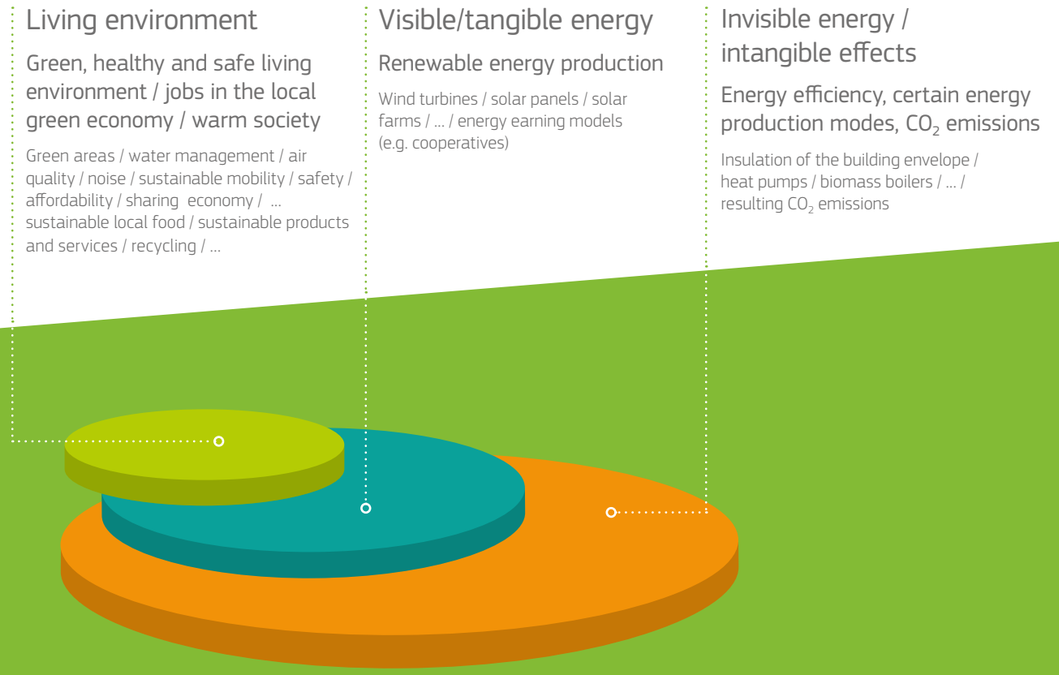
4 Examples of combined accounting energy – social welfare and health are difficult to find. The Oldham case is a rare example (and not part of a EU SCC co-funded project in scope for SCIS), see https://www.theguardian.com/society-professionals/2016/nov/30/guardian-public-service-awards-2016-sustainability-winner-warm-homes-oldham

5 https://www.euractiv.com/section/energy/interview/bendt-bendtsen-mep-time-for-eu-countries-to-draft-building-strategies-well-be-watching/ 'Countries now have a responsibility to estimate the wider benefits of renovation, including health and indoor climate.'

6 Experiences noted from City-zen and from the Dutch Energiesprong programme, see also BPIE (2016), Scaling up deep energy renovation - unleashing the potential through innovation & industrialisation; http://i2-4c.eu/wp-content/uploads/2016/10/BPIE_i24c_deepretrofits.pdf.

Figure 3: Spheres of involvement and relation with motivational power and willingness to pay

Another aspect that deserves more attention is the willingness to pay. Experiences in energy efficiency projects throughout Europe indicate that the main triggers for homeowners to (energy) retrofit their houses are not the savings on the energy bills (that is, the payback time). Other arguments are much more important like increased comfort and a healthier or a more beautiful home. In the order of priorities, the energy bill savings may come on the third or fifth place[6]. An energy retrofit could be triggered by renovating the bathroom and the kitchen at the same time, by accessibility improvements, or even a homeowner seeing his neighbour's renovated property. It is important to note that energy and CO_2 are invisible and therefore tend to stay out of people's mental framework. Integrating them with 'visible' changes may help to increase the uptake of energy- and CO_2-related measures, see also Figure 3.



5. REGULATORY BOTTLENECKS SUSTAINED BY VESTED INTERESTS AND SYSTEM INERTIA

A specific reason for business as usual being favoured over the replication of innovative solutions is that regulatory frameworks are often designed for the status quo rather than for change. This holds in particular for regulations at the end of the implementation tree: Often an interconnected web of detailed regulations needs to be reconsidered before an innovation can be implemented. This comes with a lot of effort or through 'regulatory sandboxes' that release the ties temporarily or within a spatially confined area.

SOME RELEVANT EXAMPLES:

- Regulatory freezing often occurs in spatial planning. Planning rules tend to settle functions and their related border conditions as if these would remain forever, while the use of space is in constant transformation. Providing legal certainty is a main reason for the tendency to cast in iron the use attributions of space.
- While the EC is designing new regulatory frameworks that will better facilitate the clean energy transition with its peer-to-peer prosumer setup, projects continue to struggle with the existing rules, in particular those regarding the electricity market.
- EU directives are translated into national legislation, leaving space for interpretation. Partly, this intends to provide for the (political) manoeuvring space to have related laws adopted at the national level in every member state. On the other hand, these ambiguous interpretations lead to different implementation contexts for smart city projects, renewable energy infrastructures, etc. Like this, certain innovative and/or desired setups may be easier to realise in one country than in another, or may be entirely blocked off. An often-cited example regards Spain where installing photovoltaics (PV) is discouraged from many points of view[7] . Amongst others, the fines for not properly declaring or running a PV installation are higher than the fines for spilling radioactive waste (and may amount to 60 million Euros[8]). In this case, the vested interests of the traditional energy players have heavily interfered in the setup of the regulation, consequently stopping the desired energy transition.

At present, sub-optimal solutions are commonly being implemented in smart and sustainable city projects because the initial (and better) proposal was blocked off by legal bottlenecks. This also hampers the development of performant business models.

The input-output leverage factor of legislation that envisages change rather than the status quo can, however, be high, and such regulation may result to be cost effective in the long term. A historical and still ongoing example is the situation where the EU obliges car manufacturers to build energy-efficient vehicles with limited carbon emissions, ultimately resulting in competitive advantages[9] .

Where regulatory changes lag, there are reasons why this effective factor is disregarded.

7 At the time of editing the present text, laws concerning PV in Spain are being amended.

8 See e.g. https://www.ibesalliance.org/index.php?id=31&tx_ttnews%5Btt_news%5D=148&cHash=232d161f83efb6e80ef06ba861c3f405, https://www.pv-tech.org/news/spain_proposes_sun_tax_on_storage_of_self_consumption_solar?/mobile/news/spain_proposes_sun_tax_on_storage_of_self_consumption_solar

9 See e.g. https://www.theicct.org/sites/default/files/publications/Auto-Industry-Intl-Competitiveness_ICCT_Briefing_23052017_vF.pdf

Transition studies have demonstrated that power matters. Vested interests negatively interfere with system changes needed for the low carbon transition. Such interest should not uniquely be of a financial-economic or power-related nature. Parties may simply be resistant to change or lack competences, time and knowledge to adapt to new settings.

Re-reading the rules may be a simple solution. Many project actors think along established lines of action, also when it comes to interpreting the regulatory context. In this way and following the common routines, it is often decided that an innovative intervention is not possible due to given legislation. However, practice reveals that restudying the given rules may bring forward possibilities that were previously ignored.

Sometimes certain actors like Distribution System Operators (DSOs) are observed to assign themselves decision powers that legally are not theirs. By ignorance and routine, the power position of the actor is accepted and its agenda followed. Carefully observing the source regulation brings forward alternative pathways that were judged not possible at first sight.

6. POLITICIANS ARE NOT (ENOUGH) ON BOARD

For competences influencing the low carbon transition, today's decision arenas tend to suffer from a phenomenon that has been coined *announcement policies*[10]: while declaring the public interest of interventions in general terms, the fear of implementing concrete measures and thus meeting the resistance from the voter fuels stagnation. Like this, politicians remain trapped in a short-term policy cycle and political routines are not up to the societal challenges we face.

At city level, the image is mitigated. The announcement policy syndrome may be reflected in politicians echoing the main story lines of smart and sustainable urban development, but not going much deeper. The stance taken is reactive: if an important share of urban stakeholders takes up an innovative solution and thus outweighs the resistant part of the population, then the decision maker follows – instead of leading.

However, there are also examples of the opposite, and these systematically involve more visionary politicians with a long-term outlook[11] and no fear of (temporary) resistance. In the domain of mobility, the switch of paradigm operated in cities like Nantes (France's tramway reintroduction pioneer in the 1980's), Pontevedra (with its much showcased car-free city centre), Stockholm (step-by-step introduction of a city toll) or Ghent (rolling out an ambitious mobility plan including limiting private car use) are noticeable examples.

An emerging societal split over the environment. The lack of response from the political world in addressing urgent environmental problems has led to a new stage where authorities are brought to court by specific stakeholders or groups of citizens, in order to forcefully reiterate the responsibilities these authorities have for safeguarding the environment, and thus the common interest.

As, for example, in the domains of climate action and reducing environmental pollution:

- *De Klimaatzaak*[12] won a case against the Dutch government, both in first instance and in appeal, for them not undertaking enough action to prevent climate change. The concept of the Klimaatzaak (Climate Case) is being repeated in other countries like Belgium, and legal cases over climate action in different forms are now appearing on a global scale[13] .
- In Germany, there has been a series of cases defended by lawyer Remo Klinger (Deutsche Umwelthilfe) to ban diesel cars from inner city areas[14] . The success of these cases is inspiring NGOs all over Europe to do the same in other countries.
- In Belgium, a recent court ruling obliges the Flemish regional government to come up with an effective plan to fight air pollution[15] .

In all cited cases, governments are failing to comply with international agreements or regulations. This is a new development compared to other historical instances of 'juridical activism'. The referred agreements or legislations range from human rights over international and EU level agreements to specific EU regulations. This seems to point to the importance of international frameworks for overcoming the 'local policy trap' and would provide a strong incentive for the EU to stay at the front of regulation that safeguards the environment. As a particular benefit, local politicians can 'blame Europe' for the high standards and thus create more manoeuvring space for having these stringent rules locally applied (at the risk of feeding more Euroscepticism if not properly handled). To a certain degree, EU level action can thus remediate the 'everyone or no one' dilemma discussed above.

10 In Dutch for example, specific terms have been coined like 'aankondigingsbeleid' (BE) or 'intentiepolitiek' (NL).

11 This can be linked to strategic plans or even structures (as of example, ProjectZero in Sønderborg, DK) and relates to the 'city journey' or an established, consensus-based long-term vision.

12 https://www.theguardian.com/environment/2018/oct/09/dutch-appeals-court-upholds-landmark-climate-change-ruling and https://www.nrc.nl/nieuws/2018/10/10/zit-de-rechter-nu-op-de-stoel-van-de-politiek-a2417570 (in Dutch)

13 https://www.theguardian.com/environment/2018/mar/20/can-climate-litigation-save-the-world

14 http://www.standaard.be/cnt/dmf20180504_03498780; https://www.reuters.com/article/us-volkswagen-emissions-frankfurt/german-court-says-frankfurt-must-ban-older-diesel-cars-idUSKCN1LL2GC; https://www.theguardian.com/environment/2018/feb/27/german-court-rules-cities-can-ban-diesel-cars-to-tackle-pollution

15 https://www.susanova.be/artikels/vlaams-luchtkwaliteitsplan-moet-concreter-en-ambitieuzer (in Dutch)

Challenges at the Level of EU Regulation

1. PROVIDING SPACE FOR A WHOLE SYSTEMS APPROACH

Specific regulation is sometimes conceived as focussing on one system component, product, service, etc., thus rendering it difficult or impossible to develop alternative, integrated solutions at a higher scale. The challenge might lay at the level of EU directives or at the translation into national law.

An example of this situation is the focus of the energy efficiency (EE) policy, e.g. via the Energy Performance of Buildings Directive (EPBD), on the single building level, whereas urban energy matters need to be addressed from an overarching energy vision. This higher level vision may, for example, lead to certain parts of the built environment not being retrofitted following established EE standards, but rather being serviced by high temperature waste heat through a District Heating and Cooling (DHC) network because this is the economically and environmentally most efficient solution. A typical example would be historic city centres where deep energetic retrofit is expensive, undesirable or even forbidden for reasons of cultural heritage (many European UNESCO protected city centres are a relevant example hereof, but the situation holds for a much larger part of the building stock). These buildings could undergo retrofit without increasing the EE according the standard EPBD desired levels, but be serviced in another effective way (in case of the DHC system)[16] .

It is recommendable that specific regulations allow for this type of trade-off at a higher, aggregated scale level as far as it can be proven that the trade-off is beneficial from the economic, social (including cultural as for heritage) and environmental perspective. This may imply the need for multi-criteria assessments and the set-up of proper guiding frameworks.

16 The EPBD recognises the need to further investigate measures at a higher scale level than the single building and sets out a timeline therefore, more particularly under the reviewed article 19 *'... the Commission shall examine in what manner Member States could apply integrated district or neighbourhood approaches in Union building and energy efficiency policy, while ensuring that each building meets the minimum energy performance requirements, for example by means of overall renovation schemes applying to a number of buildings in a spatial context instead of a single building.' (https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32018L0844&from=EN)*

2. TENSIONS BETWEEN REGULATION FIELDS

Smart city projects and investments in energy efficiency and renewable energy infrastructures require enormous upfront investments and intense public-private or even public-public collaboration. Two EU principles from the financial/market policy often hinder these processes, namely:

- **Budgetary rules** requiring public authorities to have the budget in balance on a yearly basis. Like this, public authorities cannot, or only with great difficulty, invest large sums in EE or RE measures that pay themselves back over a given timespan and are even budget positive in the long term. Recently, some legal fixes have been made to this problem[17] , but reactions from the field of practice indicate that the intervention is not effective enough and keeps holding public bodies back from making such investments[18] . Where Energy Performance Contracting (EPC) is envisaged as a solution, it is to be noted that EPC contractors most often work on a basis of short payback times, thus discarding many EE/RE interventions.
- **EU level market and funding rules** make it difficult for public authorities to co-invest in projects and infrastructures for the public interest (e.g. RE installations). An example is the *Sociétés Publiques Locales* (SPL) in France: 100% public-public collaboration vehicles at 100% public funding for projects of public interest, but they are considered by the EU as enterprises that may receive a maximum of 70% of public funding. Other bottlenecks arise at the level of public tendering rules. Public institutions are prevented from working together in a targeted and innovative way with specific market players because a tendering procedure must always be set up. Private companies are reluctant to such collaboration by fear of being accused of prior knowledge in a subsequent tendering process. In fact, all EU funded projects must, in this regard, be considered as violating the EU market regulations to a certain degree as they start from a non-tendered consortium basis.
- In the transition towards a peer-to-peer energy prosumer model, bottlenecks reside at the levels of the electricity grid and market regulations. Tensions arise between the technical requirements of keeping the electricity grid in balance at every moment, the de facto situation of decentralised and multi-actor production and the guaranteed principles of a free market. Rules regarding the easy switching of energy suppliers hamper the development of long term engagements in a local energy system and thus also the investments in it. Furthermore, the current regulation neglects the connections and exchanges between the different energy carriers typical of a (local) multi-energy system. Putting flexibility to work remains difficult or impossible. Unbundling obligations impede setting up 'whole' systems at the local level that include production, transport and consumption[19].

17 19 September 2017 - revised guidance note on the recording of Energy Performance Contracts (EPCs) in government accounts, http://europa.eu/rapid/press-release_IP-17-3268_en.htm

18 https://ec.europa.eu/energy/sites/ener/files/documents/session2_public_buildings_invited_honnay.pdf

19 Kessels, K., Alkano, D., Virag, A., Cardinaels, W. (2017), Upgrade of models for use in simulations of multi-commodity market models, SmarThor project (project funded by Provincie Limburg, Agentschap Innoveren en Ondernemen, EFRO and the EU)

3. THE COMMONS VERSUS THE MARKET

Considered at a deeper system level, both the tensions described in the previous chapter and several of the discussed replication barriers point towards a societal dilemma regarding the shared ecosystem services, as metaphorically described by Garrett Hardin in his *Tragedy of the Commons*[20]. Hereby the economic interest of the single actor (operating in a legitimate market context) somehow hurts the common interest. Where this damage remains limited at the scale of the individual actor, the result of the aggregated effects becomes a critical damage at the level of society, leading to a lose-lose situation for all.

In the field of energy and carbon emissions, some related observations can be made:

- Sun, wind, hydropower, biomass and environmental heat as sources of renewable energy are, to differing degrees, commons. Their role in the safeguarding of another commons, a liveable climate, is essential. Therefore, their inclusion in a market based exploitation paradigm will require a balancing exercise, weighting the common interest versus the particular benefit. This balancing exercise may need to be reflected in the set-up of public-private partnerships and be difficult to accommodate with the current regulation formats.
- The renewable energy system of the future is of such complexity, in particular with regard to its temporal balancing challenges and the role of a multitude of decentralised prosumers, that its design cannot be made based on simple market rules. The expected complexity requires trade-offs between rights and obligations that transcend the simple demand-offer paradigm (e.g. for the balancing responsibilities and the pricing mechanism that resorts under it versus no fail requirements).
- In the field of mobility, a difficult trade-off emerges between the right to access and mobility on the one hand, and the right to clean air and living quality on the other hand. The legal cases over the place of the (diesel) car are illustrative of this conflict. Here, individual mobility rather belongs to the private right, a clean and safe environment shall be regarded as a commons to be safeguarded. The difficult point is the infinitesimal contribution of the car driver to environmental degradation, climate change and traffic accidents. Therefore, this conflict resorts under the same dilemma as the one described in the Tragedy of the Commons. Considering mobility as a product or a service from a narrow techno-economic perspective cannot solve this conflict.

20 Hardin, G. (1968), The Tragedy of the Commons, Science, http://science.sciencemag.org/content/162/3859/1243

CONCLUSION

This report demonstrates that the replication of smart city solutions to support the transition towards a low-carbon society is not only a matter of implementing the required technologies at scale. In addition, there is the big challenge of motivating and involving the end users in adopting new lifestyles; in having the appropriate financial incentives in place to construct a different economy; and to overcome the regulatory bottlenecks that appear at the time of a system's paradigm shift.

Although resistance to change may hinder the corresponding transition efforts at many levels, there are always opportunities to grasp. Successfully implementing smart and sustainable city solutions may occur when the right actors with the proper means at their disposal can together realise a breakthrough project. Hereby, we must take into account the fact that cities are, in the first place, communities with their particular local connotation, requiring any solution to be context-sensitive. The resulting "biodiversity" of integrated city solutions does however not imply that standardisation and upscaling of solution components is not possible, neither that a particular success in one place cannot incite others to embark on the creative city journey too – herein lies definitely a secret of replication.

The repercussions for EU policy may equally qualify as a paradigm shift. Incremental regulatory changes may not be effective enough to accommodate required change at the required speed, and current overall policy frameworks may be, at least to some degree, contradictory. It requires systemic insight and political courage to address these challenges, but both research outcomes and practical experiences indicate that it can be very rewarding to do so.

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GLOSSARY / LIST OF ACRONYMS

BAU	business as usual
DHC	district heating and cooling
DSO	distribution system operator
EC	European Commission
EE	energy efficiency
EPBD	Energy Performance of Buildings Directive
EPC	energy performance contracting
EU	European Union
ICT	information and communications technology
PV	photovoltaic
RE	renewable energy
R&I	research and innovation
SCC	Smart Cities and Communities
SCIS	Smart Cities Information System
SPL	Société Publique Locale
WP	Work Package

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