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Developing New Business Models for Sustainable Urban Design

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A Big Question is do we "Europe" have agile infrastructures, network systems and operational models for developing and maintaining smart grid applications for our city districts and can we extend our Hyper Connected World through Internet of Things and Big Data? This paper will evaluate architecture models for designing complex systems such as the rise of agent-based systems and their potential to apply knowledge in the form of rules to transform input to output facts for decision making purposes that can adapt to their behaviour. As the preferred alternative model is expanded to help manage the system throughout its life cycle, New Business Models are designed based on operations to capture value i.e. upstream supply chain and downstream distribution. This paper will investigate business models that focus on energy management at the neighbourhood level within a marketing context. The final section will discuss the results of choosing a model suitable for multi-agent based systems for sustainable district and urban design.

Keywords: Business Models, Internet of Things (IoT), Sustainable Urban Design, Energy.

1 Introduction

Yanrong et al. [39] acknowledge that an integrated understanding of the smart city concept, smart city projects are part of a general concept of city modernization. They also recognize that the contribution and benefits of Information Communication Technology (ICT) to modernization can be considerable, smart city projects should never be seen in isolation, but as one element in a city's (or regions) continuous effort to find the next best way of operations.

Chen [9] stated that business models have to take into account the capabilities of Web 2.0, such as collective intelligence, network effects, user generated content, and the possibility of self-improving systems. He suggested that the service industry such as the airline, traffic, transportation, hotel, restaurant, ICT and online gaming industries will be able to benefit in adopting business models that take into account the characteristics of Web 2.0.

This paper will show the new challenges for the European Union in relation to smart grids and integration. It will also highlight the European Energy Union strategy for bridging the gap analysis (identifying user's operational needs for developers in order to deliver systems, products and services [40]) associated with an energy market, security and decarbonisation requirements and risks. Two desktop case studies are presented in order to show; i) how European products are being developed through Agent-based technology as a financial instrument and ii) collaboration with China via successful business models for infrastructure development. The paper categorizes a traditional business model strategy in contrast to Business Process Re-engineering (BPR) for Web service development, thus outlining the need for new innovative approaches to new market segments. A system performance specification for Distributed Automated System is presented based on a hybrid approach (Hardware and Software) and Java based framework, or alternatively 'open source based framework,' illustrating the importance of the smart grid and its communication system. The final section highlights Europe's potential to be a leader in multi-agent systems.

2 Problem Statement

The need for reducing energy emission is not only about environmental impacts but also financial. IMF [22] has recognised that the current unsustainability patterns of energy usage do not only relate to costs and risks but also require large investments in green energy sources related to the transition to a low energy emission model. Eyraud and Benedict [18] identified that this has created a market for investing in renewable energy such as solar, wind, biofuels, biomass and geothermal heat which has increased from $7 billion a year to $154 between 2000 and 2010. Runyon [34] further emphasized the market opportunities and competitive advantages of clean energy investments with China, Africa, the U.S., Latin America and India driving the world to the highest ever figure of $329.3 billion in 2015 with more investors set to enter the market in 2016.

The European Union stresses the fact that utilities and Distribution System Operators (DSOs) are facing new challenges in managing their grids with increasing penetration of flexible distributed market, especially with integration of renewables (expected to be up to 50% by 2030 as a clear target established by the European Commission). However, a *Big Question* is does Europe have agile infrastructures, network systems and operational models for developing and maintaining smart grid applications for our city districts and can we extend our Hyper Connected World through Internet of Things and Big Data?

2.1 Energy Union

PwC [30] identified the challenges associated with staying within the 2˚C global carbon budget such as the fact that the decarbonisation rate needs to be 6.3% every year to 2100. PwC explains that by "continuing on the current business as usual trend, the 2˚C carbon budget will be exhausted by 2036." In short, this means the carbon budget allocated for this century will be spent in the next 15 years. The report indicates the significance of this 6.3% by highlighting the fact that it is double the rate of decarbonisation achieved following the restructuring of Germany's industry and power generation after reunification in 1990.

However, it also shows positive aspects developed from posting in 2014 which was the first year that more than one country achieved a rate of 6% or above. Four countries in particular made significant contributions; UK reached 10.9% decarbonisation, whereas France reduced more carbon emissions than the UK but experienced slower GDP growth. Both Italy and Germany achieved strong decarbonisation rates and emission fell rapidly but Germany did manage an economic growth of 1.6%.

In order, to achieve customer requirements, controls (such as; applicable laws and regulations, industry standards, agreements and project procedures) and enablers (organization/enterprise policies, procedures, and standards, organization/enterprise infrastructure and project infrastructure) must be considered as part of the technical analysis and decision making processes [21].

On 25 February 2015 the European Commission unveiled a Strategy and Action Plan for creating an Energy Union. The strategy focused on; i) a fully integrated European energy market, ii) addressing energy security through solidarity and trust, iii) promote energy efficiency to moderate demand, iv) decarbonise the economy and (v) support the necessary research, innovation, and competitiveness.

European energy market – the report suggests that a 'software update for the energy market, rules' is needed to make energy flow freely across borders. It identifies that market integration should not be held back by nationally focused regulation because this process has created "unnecessary administrative and transaction costs and discouraged investments". The report does acknowledge that Europe is replacing these national rules with EU Network Codes that set a framework for cross-border energy trading.

Energy security – the interconnections of energy flow requires a fully functioning, EU wide energy grid that connects Member States within the internal market. The report promotes the use of integrated renewables such as promoting intelligent energy use and ending disconnected energy 'islands'. Projects such as the proposed European Fund for Strategy Investments, as part of the investment plan for Europe includes energy infrastructure. In order, to eliminate energy islands the report shows that electricity highways from the emerging 'Northern Seas' offshore grid (covering the English Channel and the Irish, North and Baltic Seas), giving life to a truly pan European electricity system.

Decarbonise the economy – in order to create an energy-efficient and decarbonised transport sector the report emphasizes that support must be given to the build-up of infrastructure for alternatives fuels and electricity and the market uptake of vehicles. In essence "transport electrification has been identified as been crucial, requiring full integration with urban mobility policies and the electricity grid."

Promote Energy Efficiency - the report outlines that consumers globally pay the same for oil and coal on the international market in contrast to electricity and gas prices. With regards to gas prices, the report explains that these prices are often national or sub-national (a region within nation) and they have the greatest effect on consumer prices and risk of undermining the Single Market. This problem relates to the consistent rise in electricity and gas prices. Another contributing factor stems from not converging the difference between national prices to European prices and improving market efficiency. This issue creates additional costs on European house-holds and affects Europe's global competitiveness. As part of the renewable energy sector commitment, European Renewable Energy Companies employ over a million people, and have a combined annual turnover of €129 billion, and hold 40% of all patents for renewable technologies.

Support the necessary research, innovation, and competitiveness – initiatives such as the European Innovation Partnership (EIP) on Smart Cities and Communities have assisted European cities in growing smarter together. As the report demonstrates there has been 370 commitments to fund and develop innovative solution to challenge and bridge gap analysis such as traffic congestion, air pollution, and high energy costs. These commitments have been attributed with monetary support via co-funding through the Horizon 2020 Smart Cities lighthouse projects that will create smart cities and thriving hubs for innovation [16]. Figure 1 created by the authors shows a graphical representation of the Energy Union strategy.

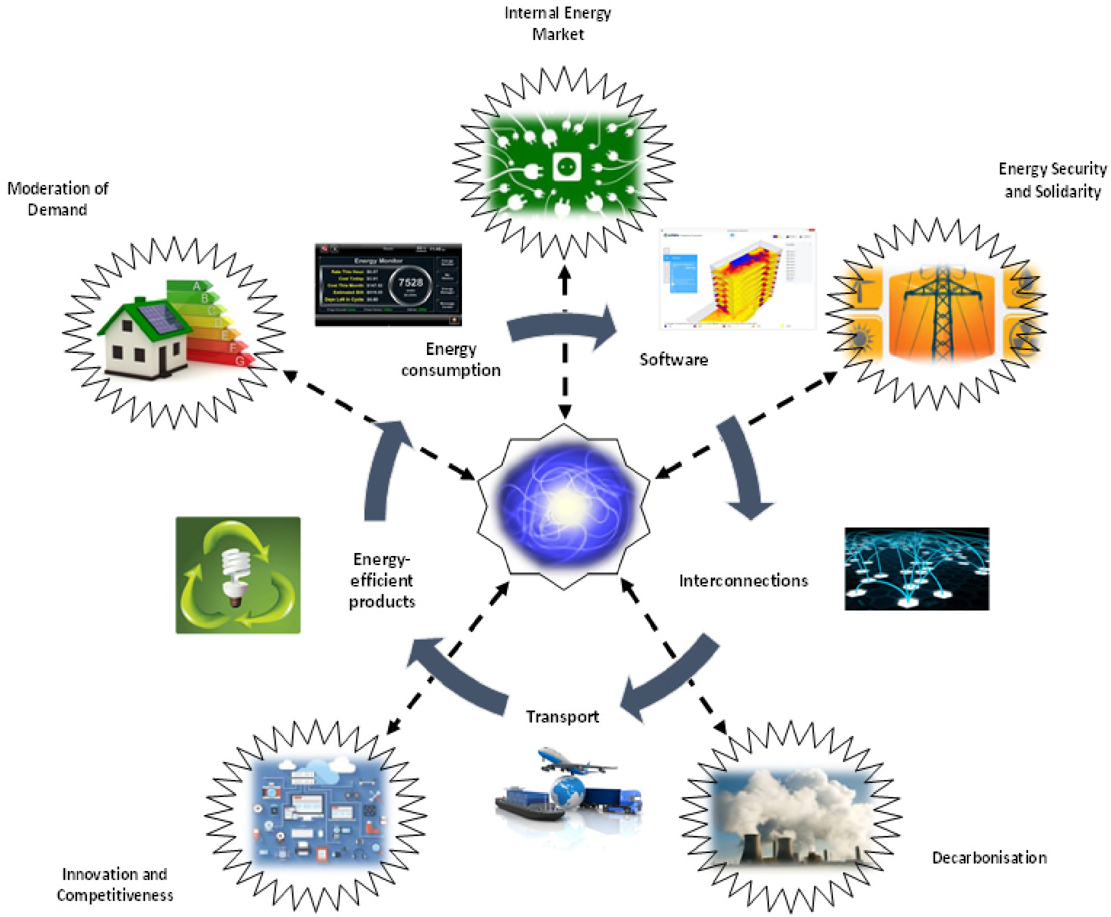


Figure 1 The Five Key elements of the Energy Union strategy

2.2 Europe's decarbonisation challenge

IEA [20] recognised that there was a significant difference between gas and electricity prices across regions. Within the context of competitiveness the report identifies that higher energy prices in Europe and parts of Asia, particularly Japan have initiated calls for urgent action to prevent the decline of industrial heartlands.

businessGreen [8], revealed the true value of electricity by highlighting its attributes as "a key part of the solution to Europe's decarbonisation challenge. businessGreen acknowledges that by replacing fossil based systems with electric technologies will make a major contribution to meet Europe's climate change targets as the power sector is fully committed to reducing CO_2 emissions by 80-95 per cent by 2050.

businessGreen emphasizes that as the market becomes saturated with electricity dependent items; electric vehicles, heat pumps, smart technologies controlling energy consuming appliances, and heating systems based on low carbon generation, such mass deployment will help transform the energy sector and cap the emissions of the heating sector within the EU Emissions Trading System (EU ETS). However, businessGreen also recognizes that the major obstacle to blocking the use of technologies involved is the energy costs placed on electricity bills which is more expensive than fossil fuel alternatives. They emphasize that there is a need to "clean-up the electricity bill" and develop smarter financial instruments that can increase private investment in new technologies in order to replace obsolete ones.

Table 1 Electricity prices of household consumes NAT\ kWh

Year	EU-28	EA	Belgium	Ireland	France	Cyprus	Latvia	Lithuania
2008s1	0,158	0,165	0,197	0,177	0,121	0,178	0,059	0,297
2008s2	0,166	0,172	0,215	0,203	0,120	0,204	0,071	0,299
2009s1	0,164	0,174	0,192	0,203	0,121	0,156	0,074	0,329
2009s2	0,164	0,173	0,186	0,186	0,121	0,164	0,074	0,320
2010s1	0,167	0,177	0,196	0,180	0,128	0,186	0,074	0,399
2010s2	0,173	0,182	0,197	0,188	0,135	0,202	0,074	0,420
2011s1	0,180	0,190	0,214	0,190	0,138	0,205	0,083	0,419
2011s2	0,185	0,195	0,212	0,209	0,142	0,241	0,095	0,422
2012s1	0,188	0,198	0,233	0,216	0,139	0,278	0,097	0,435
2012s2	0,197	0,206	0,222	0,229	0,150	0,291	0,095	0,438
2013s1	0,200	0,212	0,217	0,230	0,152	0,276	0,097	0,473
2013s2	0,202	0,215	0,222	0,241	0,160	0,248	0,095	0,480
2014s1	0,204	0,216	0,210	0,241	0,159	0,229	0,137	0,459
2014s2	0,206	0,218	0,204	0,254	0,162	0,236	0,130	0,455
2015s1	0,208	0,219	0,213	0,243	0,162	0,196	0,164	0,126
2015s2	0,211	0,221	0,235	0,245	0,168	0,184	0,165	0,124
2015s2& 2015s2 in %	**2,4**	**1,4**	**15,2**	**-3,5**	**3,7**	**-22,0**	**26,9**	**-72,7**

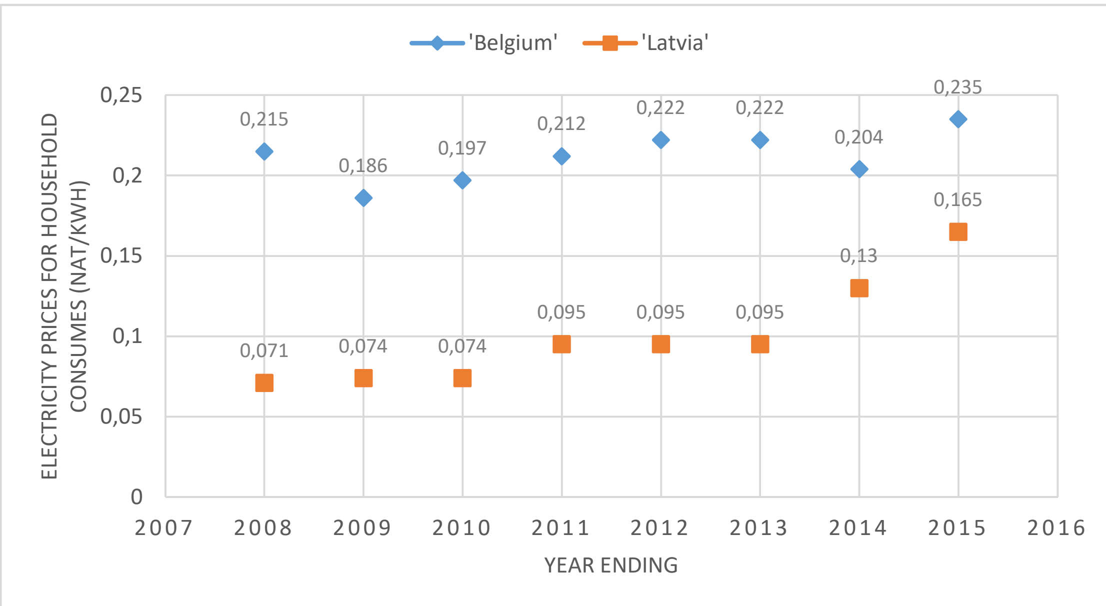
According to Eurostat [17] the price and reliability of energy supplies, in particular electricity is a key focus point in a country's energy supply strategy. The fact that electricity represents a significant proportion of total energy costs means that its prices are of significant importance percenta for international competitiveness. The report found that for medium sized household consumers, electricity prices during the second semester of 2015 were the highest in the EU in Denmark (EUR 0.304 per kWh), Germany (EUR 0.295 per kWh) and Ireland (EUR 0.245 per kWh). The price of electricity for households in Denmark was more than 3 times higher than the price in Bulgaria (EUR 0.096 per kWh).

The average EU-28 price for electricity is EUR 0.211 per kWh. Table 1 is an extraction from the electricity prices for household consumer's comparison 2015s2-2014s2 (NAT kWh). All prices include taxes and VAT in national currency (NAT) and its percentage changed during the last 12 months.

The countries Cyprus (-22%) and Lithuania (-73%) were chosen because of their decrease in electricity prices between the second semester (s2) of the years 2014 and 2015 (as highlighted in green). Latvia (27%) and Belgium (15%) show an increase in electricity prices for the same period. Ireland was chosen because its price of EUR 0.245 per kWh for 2015s2 was one of the highest in Europe but it is a reduction from the previous year's same semester price of 0.254 per kWh. The option to select France refers to the country's ability to reduce carbon emissions while keeping the price of electricity at EUR 0.168 per kWh for 2015s2. Eurostat does identify that between the second half of 2014 and the second half of 2015, electricity prices for households decreased in 12 EU Member States.

Table 2 data is extracted from Table 1, as the figure depicted on the graph in Table 2 are highlighted with rectangles on Table 1. Belgium and Latvia were chosen because they arguably represent the highest and lowest prices. The graph shows how Belgium electricity price since 2008s2 has been high and fluctuating temporarily whereas Latvia has been increasing steadily.

Table 2 Electricity prices of household consumes NAT\ kWh between Belgium and Latvia



Deloitte Conseil [12], showed that nuclear and gas are Belgium's main electricity sources, providing 87% of the country's electricity in 2013. 29% of the country's 21 GW of electricity capacity came from nuclear plants that produced 57% of the country's electricity. Gas represent 23% of the country's 21 GW reflecting 29% of the electricity output. Renewable energy represented 34% of the country's power capacity. This report also indicated that nuclear generation is planned to be phase-out between 2015 and 2025.

Understandably, this will present real challenges for Belgium because of its low rates of electricity production capacity that could cause shortage of supply if imports cannot fill the gap, especially during the high demand peaks of the winter season. The issue with Latvia electricity prices originates from the insufficient amount of electricity generated in its power plants. Latvia relies on importing its shortfall of electricity supply needs from Russia [24].

2.3 Internet of Things and Big Data

Biggs et al. [6] recognized that Internet of Things as a function emerged as early as 2005, based on the hyper-connectivity and technological advances in fields such as wireless and mobile connectivity, nanotechnology, radio-frequency identification (RFID) and smart sensor technologies. Biggs et al. identified that by connecting these services through an embedded automated internet there would be an increase in productivity and enhance the wellbeing of human welfare. ITU [23] report defines IoT as, "A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable ICT."

With regards, to IoT application in the energy sector, in developing countries, Biggs et al. have noted the rapid adoption of off-grid solar panel systems that can provide a steady electrical power to low-income families. The report acknowledges the challenges associated with grid availability, cost of services and frequent service interruptions that is in contrast to this new technology featuring photovoltaic cells, battery system and communication model. Biggs et al. identified that the off-grid IoT service enables individuals to purchase the system at a discounted rate with the capital costs repaid over the initial purchase period. Furthermore, after installation the customers are able to utilize the electricity generated from the solar cells to power their homes and regular payments can be obtained through mobile money systems. The IoT system provides a service that can also remotely monitor the amount of electricity captured/stored for future use. However, the report does also acknowledge challenges and in particular technical difficulties for ICT such as, i) reliability with regards to the durability of devices to withstand external conditions and the calibration of sensors to ensure proper measurements, ii) scalability for example; data centers require electrical power, cooling resources and space to design advancements while the connectivity to billions as opposed to millions of connected objects will create significant demands on IP networks managing the scale of device connectivity, iii) power - relating to requiring more bandwidth, iv) cost and ownership of shared models – cost of sensors and connectivity prohibitive many rural engagements and models such as sensors as a service and community ownership has proprietorship issues.

3 Investigation of Alternative Models

3.1 eCommerce

Brynjolfsson and McAfee [7], refers to Moore's Law when investigating the success of computer industry's engineers and scientists and the loose constraints in the digital world. Unlike the car industry where every year for fifty years the end product became twice as fast or fuel efficient, the computer industry has improved its pace i.e. “when communications traffic threatened to outstrip the capacity of fibre-optic cable, engineers developed wavelength division multiplexing (WDM) and transmitted beams of light of different wavelengths down the same single glass fibre at the same time.”

In relation to productivity and economic growth they aligned increases in Gross Domestic Product (GDP) per person with increases in our ability to get more output from the given inputs. They recognized the synergy between labor productivity and that of productivity growth stemming from innovation in technology and techniques of production such as the internet, mobile phones, embedded sensors in equipment for harnessing information. And they emphasized that this data will change marketing, manufacturing, finance, retailing and decision-making aspect of businesses. According to Brynjolfsson and McAfee the Machine-to-machine (M2M) communication for device sharing with one another over networks like the internet has contributed to the data explosion. In 2012 there was 2.7 zettabytes of digital data however with global Internet traffic reaching 1.3 zettabytes in 2016 “digitization yields truly big data.”

ETSI [15], highlights that eCommerce is a growing sector with huge commercial opportunity. The US government census on eCommerce reports $1.2 trillion sales representing 14% growth in 2014-2015, however $113bn was lost in cybercrime. The challenges for eCommerce relate to purchasing access because ten seconds is a long time in the context of Digital Subscriber Line (DSL), Long-Term Evolution (LTE – 4G), and 5G access speed and bandwidths. Also, eCommerce is closely tied to the application layer in the Open Systems Interconnections (OSI) Model which means Next Generation Protocols (NGP) are exposed to audit management – insecure actions of users and administrators, security – automated validation and site checking is essential, site access speed – multiple Domain Name System (DNS) lookups from site pages causes redirecting problems and compression, media unaware issues - header and image transfers of complex pages.

PwC [31] highlighted the global perspectives of the shared economy such as inviting developers to hackathons in order to share ideas and help build innovative solutions. On the challenges side insurance, trust and familiarity are the main concerns, however more access to transactions outweighs the cost of ownership. The shared economy access model is based on renting, lending, subscribing, reselling, swapping and donating. PwC does acknowledge that disruption to the marketplace is inevitable and everyone will be effected because of fast flowing technology and IoT. The report also recognizes that “companies will find ways to smartly adapt, embrace new models of operational efficiency and design experiences that work for business, employees and consumers.”

3.2 Agent-Based Systems

According to Clymer [11], “An agent-based system architecture is a network of intelligent agents that share facts with other agents and adapt their behavior in response to these shared facts; indeed, intelligent agents apply knowledge in the form of rules to transform input to output facts and to make decisions to adapt their behaviour.” The key to this statement is the fact that due to collaboration an agent-based system achieves its overall system goals plus it often exhibits emergent behavior and in some systems agents are able to learn new rules and evolve new shared facts. Section 5 of this paper ‘Performance

Assessment' will demonstrate the use an OpEMCSS model and Table 3 highlights it within a Business Model. The Operational Evaluation Modeling (OpEM) is a graphical language that describes interacting concurrent processes and how to implement them using simulation i.e. it enables experiments with complex systems and conducts simulation-based systems engineering. The Context-Sensitive Systems (CSS) relates to library blocks used to model complex systems such as, a distributed vehicle traffic control network located in a large city requiring traffic flow to optimize light timing and minimize local vehicle waiting time.

Redmond [32] identified that "by creating Web services access to resources that perform computation the provided data will be transformed instantly for example; performing a design-related task based on the inference of knowledge, such as a building type, or using Web-based Building Information Modeling (BIM) services to form a multi-agent system utilizing existing ontology languages (such as OWL definition of web ontology language) to develop a centralized Web-based system architecture automatically transforming data into knowledge output.

3.3 Agent-Based Technology – Desktop Case-Study

The Energy Hub (E-Hub) was a collaborative European project partially funded under the seventh Framework programme. Its objective was to demonstrate the full potential of renewable energy by providing 100% on-site renewable energy within an "Energy Hub District." The concept of the Energy Hub (E-Hub) is to provide a mechanism for exchanging energy via grids (households, renewable energy plants, offices, businesses) between its members which represent both consumers and suppliers. These members exchange information on their energy production needs within the Energy Hub. A key component of the E-Hub is the Mulit-Commodity Matcher (a simulation platform based on matching supply and demand). The case study tests focused on districts in Amsterdam, Leuven, Freiburg, Bergamo and Dalian (China). In order, to meet the aim of achieving low energy districts a simulation platform was developed as a consultancy tool and within this platform Business Models were identified as a main element.

The consultancy tool defined typical stakeholders associated with the business model as end users interested in a low energy bill, DSO (Distributed System Operator) interested in peak saving or reducing imbalance in the grid or society as a whole with CO2 mitigation. The technology used to match supply and demand of energy was 'Agent-based technology' and it comprised of agents representing devices operating in a market with an auctioneer agent as shown in Figure 2 and 3. The diagrams illustrates that i) each agent offering a bid to the auctioneer. This bid curve shows how much electricity the device is willing to supply or consume at different prices, ii) because producers are interested in high prices the red curve denotes a negative demand, iii) consumers in contrast are interested in consuming electricity when the prices are low, this is reflected with the blue dotted line, iv) the auctioneer aggregates all bids and arrives at a price where electricity demand and supply are equal. The result is that each device will produce the amount of electricity in its bid curve at that price. For instance; if an auctioneer determines that a price is too high for certain consumers then no electricity will be supplied to them e.g. a refrigerator with internal temperatures rising will have to pay a bit more for electricity by modifying its bid curve

(Figure 3). Overall "the higher prices can stimulate supply at critical times and lower prices will stimulate demand therefore when there is an adequate energy supply the supply can be balanced by load shifting" [14].

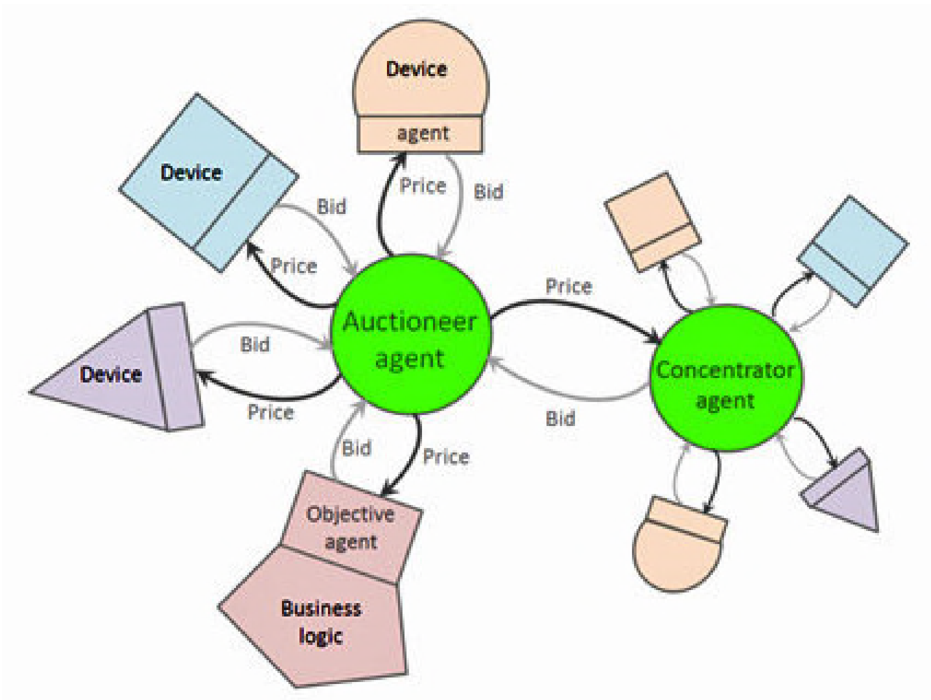


Figure 2 Agents representing devices operating in a market with an auctioneer agent (sourced from http://www.e-hub.org/agent-based-technology.html)

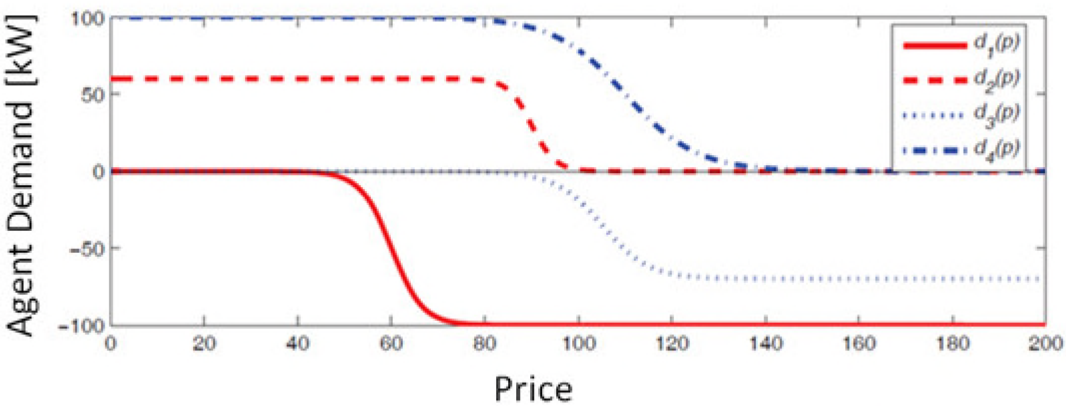


Figure 3 Bid curves offered by the agents to the auctioneer agent (sourced from http://www.e-hub.org/agent-based-technology.html)

4 Model Systems

4.1 Markets and Policies

The World Bank Report identified in 1978, that less than one-fifth of China's 975 million people lived in cities. However, over the past three decades, about half a billion have moved from rural areas to urban areas [42]. The interest in Asia is predominately based on the fact that China's market is the world's largest economy by nominal GDP and the world's largest economy by purchasing power parity [25]. The size of the potential Chinese market for Smart Cities is evident from the previous economic data and this is why expectations relating to EU-China collaboration focus has started to shift towards "software's" significant role in Smart-Cities development because it has the responsibility for city top-level design and evaluation in China. A key market growth area is gaming as noted by H2 Gambling Capital (a leading supplier of data and market intelligence on the global gambling industry) the estimated value is US$30 billion [26]. This size of growth shows great market potential for involving urban citizens with gaming techniques in order to apply energy savings, smart mobility, and better interactions with public service providers i.e. reduce demand response of electricity usage and receive credits towards tenancy payment reduction.

A comparative study of Smart Cities in Europe and China was supported by the EU-China Policy Dialogues Support Facility and initiated at the 3rd ICT Dialogue meeting in 2011 via MIIT and DG CNECT. One of the key deliverables was to 'Establish an expert framework for promoting EU-China Smart Cities cooperation. And within the assessment framework emerging trends and open challenges focused on; financing – EU and China pilot Smart Cities; business models – Public Private Partnerships (PPPs), profit/cost sharing with Telco operator, generating revenue by sharing infrastructure; Smart City services – EU pilot Smart Cities (environmental, energy and public administration); Technology – broadband connectivity, IoT, smart personal devices, Cloud computing and big data analytics [41].

4.2 New Business Models

Chen [9] emphasized that Business Model 2.0 needs to take into account not just the technology effect of Web 2.0 but also the networking effect. He gave the example of the success story of Amazon in making huge revenues each year by developing an open platform that supports a community of companies that re-use Amazon's on-demand commerce services. Brynjolfsson and McAfee quoted "As massive technological innovation radically reshapes our world, we need to develop new business models, new technologies, and new policies that amplify our human capabilities, so every person can stay economically viable in an age of increasing automation."

The B2B2X use case 'Amsterdam ArenA Innovation Centre (AAIC) produced an array of technological solutions as one of its main aims is to provide testing facilities for applied inventions (such as traffic and transport, City Wi-Fi and intelligent cameras) on a large scale covering an entire metropolitan region. Through the collaboration initiative between the City of Amsterdam and Huawei (Chinese company) and as part of their agreement, Huawei created the largest open-access wireless LAN infrastructure in the Netherlands. Its connectivity is based on HD Wi-Fi evolution, heterogeneous networks and City Wi-Fi.

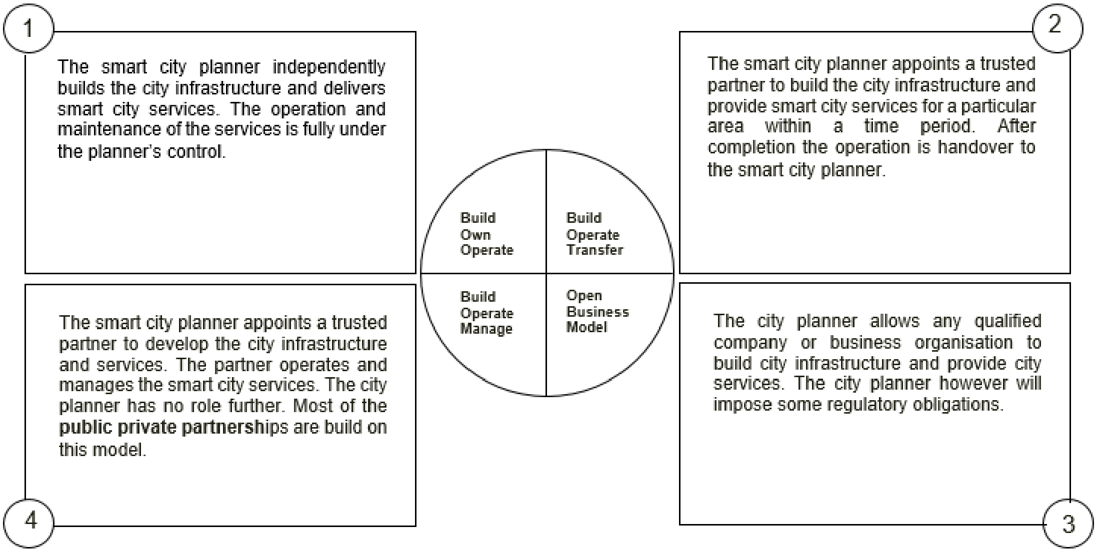


Figure 4 Common Business Models for City and ArenA (sourced with permission from Corcoran and Piva, 2014)

The Living Lab open Innovation Platform provided city applications tests to be conducted such as hackathons having full access to live data sets, Application Performance Interfaces (APIs), and latest technology allowing developers to combine their mobile application with any IoT device, open data source, open API or Cloud-based services. From Huawei advantage the results of the tests assist Huawei implementing this network service globally and from the City of Amsterdam's viewpoint it assists companies (including start-ups) in creating new technologies that will provide more sustainable urban environments. Figure 4 shows the common four business models associated with smart cities for which option 4 Build Operate Manage was the main model for Huawei and ArenA [10].

Table 3 shows a traditional strategy associated Business Models, highlighting from left to right with key elements such as development status that consists of growth strategy featuring new market segments. The table shows that new market segment comprises of new geographic segments, new demographic segments, new institutional segments or new psychographic segments and new sales for product. The lower half of the table introduces an alternative business model designed by the authors to incorporate the importance of software and system engineering. As previously noted in section 2.1 a 'software update for the energy market, rules' is needed to make energy flow freely across borders, and section 4.1 EU-China collaboration focus has started to shift towards "software's" significant role in Smart-Cities development. The techniques mentioned can be incorporated with other agile development techniques such as SCRUM ("the term comes from a game of rugby, and it refers to the way a team works together to move the ball down the field i.e. careful alignment, unity of purpose and clarity of goal come together, [35]). The SCRUM process requires "Sprint Planning meetings in order to accomplish tasks by the end of an iteration. The concept of iteration is also essential in the Spiral process as risk analysis are a major focus of prototyping. " The risk-driven sub setting of the spiral model steps allows the model to accommodate any appropriate mixture of a specification-oriented, prototype-oriented, simulation oriented, automatic transformation-oriented, on the approach to software development” [5].

Table 3 Traditional Business Strategy and Business Process Re-engineering

Traditional Strategy	Overall Market	Definition	Marketing goals	Comprehensive plan	
				Right product mix	Maximum profit potential, Sustain the business
		Market Potential	Upper limits of the market	Sales value or Sales volume	
		Development Status	Growth strategy	New market segments	New geographic segments, new demographic segments, new institutional segments or new psychographic segments, New sales for the product
		Technologies, Regulation and Standard			
		Main Shareholders	Requirements,	Exploratory Research	Questionnaires, Surveys etc.
			Constraints		
		Market Access	Drivers, barriers, benefits		
	Main Present Offers	Stakeholder Description Market Position			
	SWOT (Strength, Weakness, Opportunities, Threats)	Internal factors	*Strengths* and *weaknesses* internal to the organization	Human resources Physical resources Financial Activities and processes Past experiences	
		External factors	*Opportunities* and *threats* presented by the environment external to the organization	Future trends The economy Funding sources Demographics The physical environment Legislation	
Business Process Re-Engineering (BPR) (Avsion and Fitzgerald, 2003)	Formal Belief Network	Developing a Business Vision	Business Strategy	Concept Documents, Stakeholders Requirements, Initial Requirements Verification and Traceability Matrix	
			Drivers, Barriers and Benefits of the Solution		
			Business Model	Operation, Strategy, Structure (Lim, 2010)	
			Market Requirements	General Characteristic, Operating or Behavioural Characteristic, Physical Characteristic, Service Aesthetics (Wasson, 2006)	
		Identifying a Process to be Designed	Risk Analysis	Simulations i.e. **OpEMCSS**	
				Program Summary Analysis	Trade-Study

		Understanding and Measuring an Existing Process	Quality Function Diagram	Select Preferred Architecture Solution	MOP, MOE, RVTM
	Design and Build a Prototype of the New Process	Business Process mapping			
		Functional Architecture	Interface Control Document		
		System Architecture	Test-Bed	Verification Methods (O.Grady)	Test Plan
		Software Process	Spiral (Boehm, 1988) SCRUM		

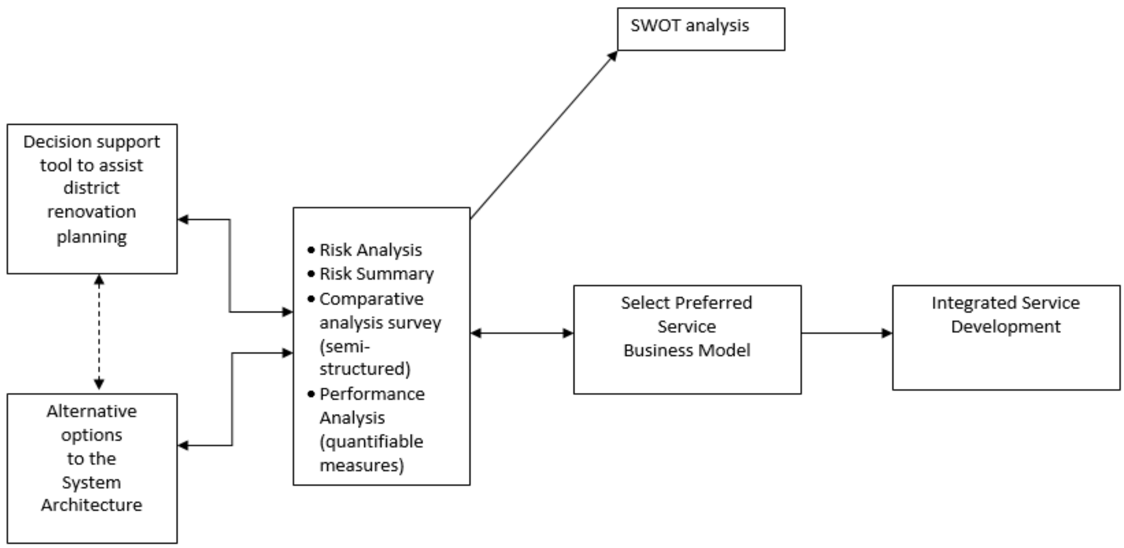


Figure 5 Business Models process diagram for integrated service development

Figure 5 is a process diagram outlining the task blocks to be considered in order to assist in the decision making development for evaluating a district renovation planning tool. The procedure requires at the system architecture stage to be investigated by risk driven studies that can test similar aspects of a SWOT analysis but focus predominately on achieving a preferred Business Model for an integrated service.

4.3 Vertical Marketing Systems

The Economist [13] defined vertical integration as the opposite to horizontal integration which is based on the merging together of two businesses at the same production stage. Vertical integration is the merging with something further back in the process (known as backward integration) i.e. a food manufacturer merging with a farm. The Economist recognizes that "businesses are downstream or upstream of each other depending on whether they are nearer or further away from the final consumer."

In relation to the software industry, Newsweek [28] questioned the use of vertical integration and referred to it as an unworkable model. They queried why companies would make their own processors and operating system when they could buy chips from Intel and Windows from Microsoft. According to Hart-Landsberg and Burkett [19], in 2003 Samsung Electronics announced that it was moving its entire PC-making business to China and prior to this LG Electronics, and Daewoo Electronics were already making their consumer durables in Chinese factories. However Asay [1], identified that Chinese Web companies are moving more towards open source and that their software stacks will be running on home grown hardware, not Western name brands. It has been anticipated that this type of architecture, will require vendors to concentrate on Cloud services because China's software industry will look like an industry filled with open source applications with no easy, proprietary crutches.

The market concern for Europe is not just the purchasing and development of software that we use for monitoring and utilizing energy efficient products but the infrastructure associated with IoT and testing applications i.e. Wi-Fi connectivity etc. As the Chinese government seeks to control their Internet infrastructure and develop its own Big Data Analytics centers, Cloud Computing service applications will become more prominent in the Chinese market-place. This type of business model will enable the Chinese government to secure all rights to their services, thus eliminating the need for proprietary licensing agreements. This vertical integration strategy, has enabled Chinese companies to own their own supply chain i.e. The Chinese-based company Alibaba has built its dominance in eCommerce by acquiring complementary companies in a variety of industries including delivery and payments.

Yanrong et al. [39] identified that cities are exploring new business models to fund their smart city projects such as i) Cloud computing (pay-as-you-go models), ii) creating revenue from data, iii) pilot projects and iv) smarter procurement. They also recognized that as part of pilot projects there has been a number of support schemes to assist innovative businesses to start-up or to demonstrate and deploy smart city innovations. For example, "in 2012, the Australian government committed to AUD 100 million to develop a Smart Grid and in 2013 the Ministry of Housing and Urban-Rural Development (MOHURD) cooperated with the China Development Bank and issued pilot projects with the line of credit to 80 billion RMB. Also in June 2013, the Energy Market Authority of Singapore was rewarded research grants totaling SGD 10 million (circa USD 8 million) for 6 pilot projects on Smart Grid technologies." As part of analyzing EU and China pilot projects for Smart Cities, the report acknowledges that, "Few examples were identified where a smart city has commissioned analysis to assess different business models for commercialising smart city services and to identify the best business model (s) for the city".

5 Performance Assessment

Clymer [11] defined the visualizing of a system as i) structural model where interface mechanisms connect one component to another, ii) functional model where inputs are transformed into outputs by each function in the network of functions, iii) the external is based on viewing the system from the outside and evaluating the interactions of the system with its external system. Overall, Clymer explains that 'The concept of function is to consider whether functional decomposition assumes defined inputs i.e. in complex systems, process threads adapt to the current environmental or system state through inputs and collaboration with other functions in order to achieve the requirements of the system.' As part of a decision making process within an overall business model, Figure 5 has been designed to functions-based systems engineering method [21] that characterizes tasks that must be performed to achieve a desired output.

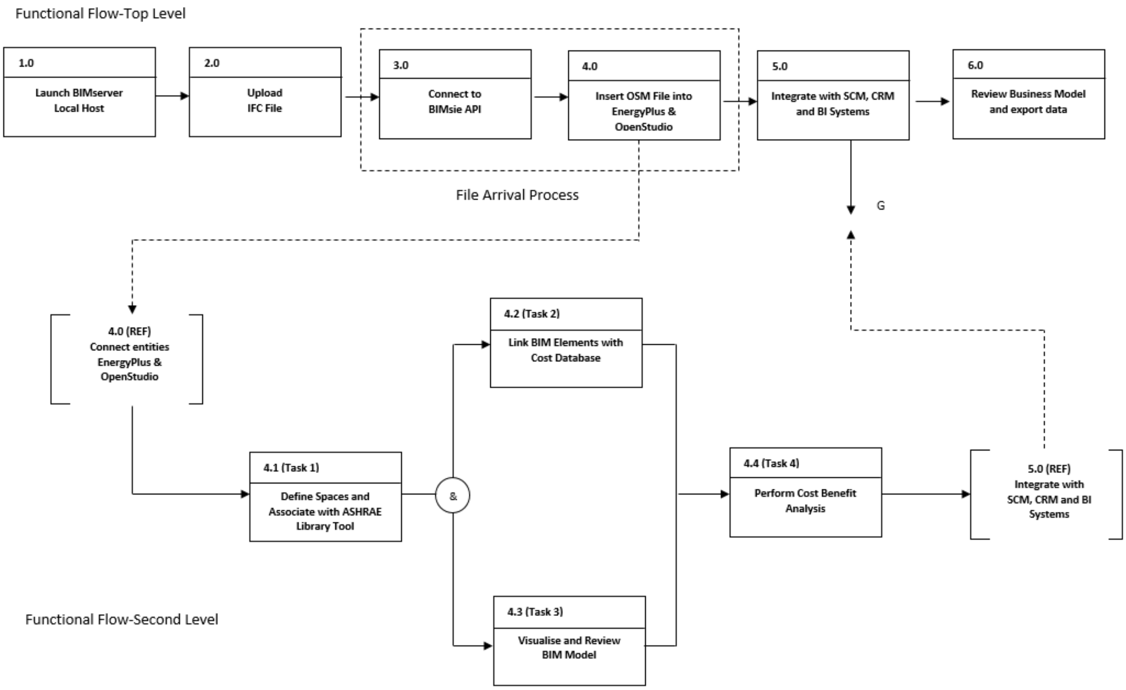


Figure 6 Functional Flow Decomposition Diagram, legend (SCM – Supply Chain Management, CRM – Customer Resource Management, BI – Business Intelligence)

Figure 6 shows the main activity tasks of an online energy and cost analysis design process from 1.0 – 6.0. However, tasks 3.0 'connect to BIMsie (BIM service information exchange) and 4.0 'Insert OpenStudio Models (OSM) file into EnergyPlus & OpenStudio relates to the file arrival process where the agents components need to be capable of perceiving and acting on their own behalf. This agent autonomous process is further decomposed into child tasks 4.0 – 5.0 that incorporate 'split action blocks' (4.2 Task 2 and 4.3 Task 3) that can be performed simultaneously but require a simulation waiting time to define the most appropriate sequence. The child agent tasks are reconnected with the top level female agents block 5.0 'integrate with SCM, CRM and BI systems. This process is shown in detail in Figure 6 using OpEMCSS.

The OpEMCSS-level model provides the structure and ontology (top-level formalisms) required to attach detailed component models for Simulation-Based Systems Engineering (SBSE). The OpEM language and OpEMCSS graphical library blocks are the background to the agent-based system architecture [11]. For example; Figure 6 exemplifies a list of tasks required for an online energy and cost analysis design process. However, Figure 7 models this Goal-Oriented activity into an organized functional flow that examines concurrent and sequential operations. This simulation defines the possible operational sequences i.e. each task has been allocated an arbitrary time unit (see task figures 1 to 4, 8 minutes have been chosen for task 2). Task 2 reaction time block represents linking BIM elements with a cost database, in reality a structured query language (SQL) database would be required as a fully functioning relational database that automatically updates the cost of material on the products profile [33]. However, the purpose of this exercise is to find the time it takes to execute the tasks. The assemble event block waits for both concurrent processes 2 and 3 to be completed before task 4, modeled by a reaction time event can start. The wait until event block shows the time required to wait until the next event is started. On Figure 6 these are indicated via cloned layer function; wait 2 – 12.666 minutes, wait 3 – 8 minutes and wait 4 – 18 minutes. The significance of this simulation is briefly explained in summary section 7.

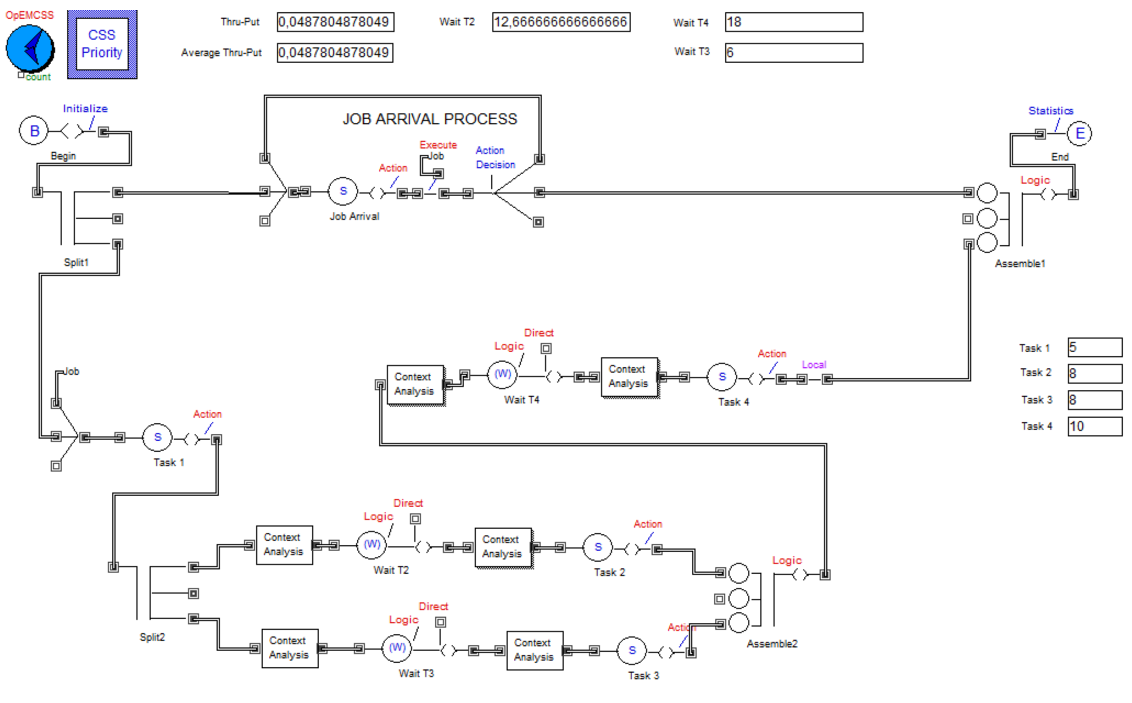


Figure 7 Agent-Based System Architecture for an online energy and cost analysis process

6 Distributed Automated Systems for IoT

6.1 Multiprocessing and Distributed Systems

"The use of multi-processors combined with centralization has been identified as an emerging trend; Barner et al. [4] and Tan et al. [36] emphasize that one should think of this as the small cluster multicore processor in a smartphone tablet, laptop that both depends upon and contributes to the Cloud." In reference to section 4.3 Yanrong et al. [39] view that cities are exploring new business models to fund their smart city projects such as i) Cloud computing (pay-as-you-go models) the authors have investigated multiprocessor systems. Auslander and Tham [2] identified that the use of multi-processors combined with centralization can certainly assist in real-time computation, simple wiring and reduction on the amount of information transmitted over long distances. They emphasized that the task structures of manufacturing control systems fit naturally into multiprocessor architectures because each priority task can be run in separate processors where they do not interfere with each other. They also acknowledge the difference between multiprocessors configuration ability to optimize each processor for specific tasks whereas massively parallel systems use regular repetition of common processor. However, they did note that manufacturing control systems follow a physical system were each processor can be optimized for its own application, meaning the processors can be of a different type and manufacturer. With regards, to designing architectures for computing efficiency i.e. scheduling vs. communication; multitasking systems invoke their overhead loss in interrupts (hardware or software indicating an event that needs immediate attention) and scheduling because the tasks share the same memory space, inter-task communication and tend to be very fast. However, with a multiprocessor systems each major task has its own private processor "so only simple scheduling is needed." Auslander and Tham also recognize the advantages of having processors that can effectively utilize synchronous software ("perhaps with cooperative multitasking") but suggest that subsystems must communicate as a whole and for this, a multimaster bus should be developed for multiprocessor applications.

6.2 Embedded System Design

The original design system relates to Tridium's Niagara Framework and Vykon products [38] which is basically a suite of Java-based products that have been designed to integrate a range of devices and protocols into a common 'distributed automation system'. In layman terms the architecture is based on a systems of systems where the overall framework encompasses various devices from manufactures accompanied with protocols also associated with their respected companies in order to synchronize data input into outputs so the electrical systems of controllers connected to sensors would be connected to the mechanical systems (HVAC controllers). The main access to the system is based on a Web browser activated by an interface supervised by a desktop software environment. The systems of systems approach is that the framework is Tridium's Niagara and the products JACE controllers are Vykon however, the protocols for some of the devices are BACnet and the java virtual machine programming runs on various windows. The authors design intention is to create within this structure a hybrid approach to the Network Design (hardware) being WiFi or twisted pair cables operated or even both. And in order, to create new knowledge and make the process more realistic the authors are also suggesting a Hybrid approach for controlling the embedded systems (hardware – network design and software – software platform) with the possibility of using opens source software for the controllers. Figure 8 shows the 'Java Based Framework' which is based on the Niagara Framework [37] with a Hybrid networking structure possibly using bus topology for passing the traffic to each PC (messaging, commands etc.) and star topology for twisted pair cabling using LonTalk protocol for communication of data – the red line indicates the process.

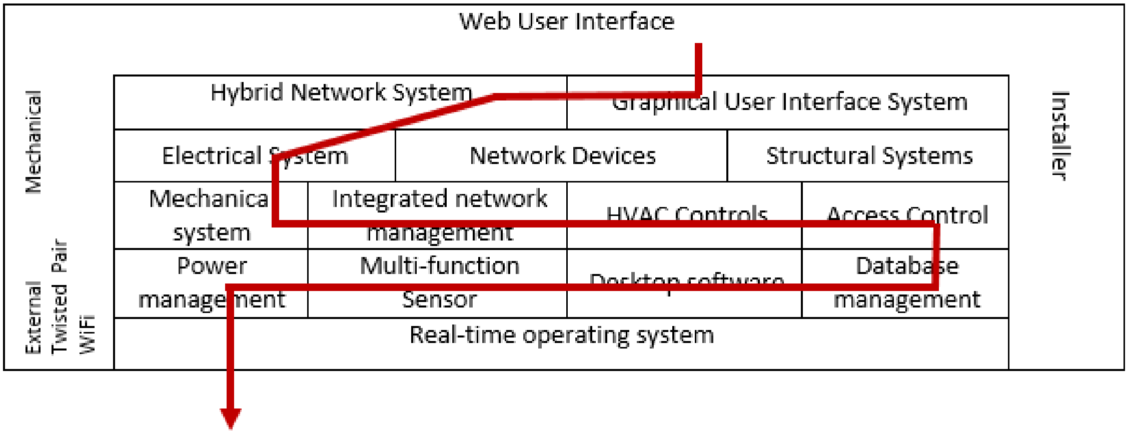


Figure 8 Java Based Framework for Embedded Systems

Figure 8 indicates the overall simple concept to design a Web user interface that will control the electrical, mechanical and security systems of a buildings automated system (small commercial size building – depending on the size of the JACE controllers chosen). The use of multiprocessor systems would assist in controlling the various devices while synchronizing their communications. As noted in Section 2.3 Internet of Things and Big Data "the IoT system provides a service that can also remotely monitor the amount of electricity captured/stored for future use" provides an opportunity for Europe to focus on Smart Grids applications and their infrastructure while also further enhancing areas of expertise such as intelligent agents that use the best resources to power and monitor real-time operations. Table 4 is a mashed-up system performance specification for Distributed Automated System based on incorporating Figure 8 framework. Figure 9 and its corresponding numbers represent the architecture for the system performance specification Distributed Automated System. The alternative rows represent features based on providing a hybrid approach i.e. stage 3 Controllers can be designed to support Cloud services directly out of the box without the need of additional gateway devices. The FG-32 leverages Open Source technology to create an Open Environment in a field controller, enabling systems integrators to create their own services and solutions directly within the field controller.

Table 4 System Performance Specifications for Distributed Automated System

Network Design (Hardware)	Networked PCs need some form of communications system that provides a fast and reliable transport system for messaging. This section discusses the hardware, cabling, and architecture used to support network communications.

1. Standard Topologies	The physical layout or description of a network is called topology. The three most common topologies are: bus, star, and ring. Combinations of these can also be used to create hybrid topologies. Niagara Release 2.3 Revised: May 22, 2002 – The bus topology uses a single backbone cable to which network devices connect. Devices are connected either directly to it or by way of a short drop cable. As message traffic passes along the network, each PC checks the message to see if it is directed to itself. Each end of the bus segment requires and end-of-line terminator.
Alternatively use Star topology	The star topology uses a central device called a hub to which each network device is connected. Network devices are connected point-to-point to the hub with a patch cable. All messages in a star topology are routed through the hub before reaching their final destination.
2. Lonworks Description	Local Operating Network (LON) Works uses ANSI/EIA 707.1-A-1999 as the protocol specification and in some cases RS-485 as the electrical specification. LonWork uses LonTalk Protocol over twisted pair, Power line (powered or un-powered) Radio frequency, coaxial cabling or fiber optics. Transformer Coupled at 78 kbps to 1400 meters; Transformer coupled at 1.25 Mbps to 130 meters; Free topology at 78 kbps to 500 meters; Power line at 10 kbps to 6000 meters; Radio at 15k, line of sight (400-470 MHz and 900 MHz)
3. JACE Controllers (Hardware and Software)	The JACE-NX is a compact PC with a conventional hard drive running an embedded version of Microsoft Windows XP and Microsoft JVM. The JACE-NX is ideally suited for integration, monitoring and control in commercial and light industrial installations. The JACE-5xx is a compact embedded processor platform with Flash Memory running Wind River VxWorks OS with a Jeode JVM. The JACE-4xx is a compact embedded processor platform with Flash Memory running Wind River VxWorks OS with a Jeode JVM. Specifically designed for light commercial applications, the JACE-403 is ideally suited for users who require a compact controller that can be directly wall mounted with direct input/output hardware (I/O) including six universal inputs and four relay digital outputs.
Alternatively use Controllers	The EasyIO FG-32 Controller is designed to support Cloud services directly out of the box without the need of additional gateway devices. The FG-32 leverages Open Source technology to create an Open Environment in a field controller, enabling systems integrators to create their own services and solutions directly within the field controller.
4. Web Supervisor (Hardware and Software)	The web supervisor is a flexible network server for multiple connected JACE stations. The web supervisor is designed to harness the power of the Internet and provide efficient integration and aggregation of the information coming into multiple JACE. In effect, the Web Supervisor creates a single view of these multiple devices, while providing a powerful network environment with comprehensive database management, alarm management and messaging services. In addition, the Web Supervisor provides the engineering environment used to set up and manage systems and a graphical user interface. This software is designed to run on Windows NT 4.0 Windows 2000, Windows XP professional and on Windows 2003 Server as long as Windows IIS is disabled. It can be connected to the Internet where the systems graphical views can be accessed using any standard Web browser such as Netscape Navigator or Internet employer.
5. Java Desktop Environment	The Vykon Java Desktop Environment is a comprehensive set of engineering tools combined into one common, easy to use graphical-based engineering environment. It simplifies the complexity of working with multiple protocols by consolidating them into one

(JDE)	common object model (Component Object Model). JDE is the tool used to set up and manage systems and to create and maintain the database that runs on a web supervisor or JACE controller.
Alternatively use Java Desktop System	Designed to thrive in a Windows-centric world, Java Desktop System interoperates with Microsoft Office files, networked Windows printers, and Exchange servers as well as standards-based LDAP, mail, calendar, and Web servers. The Java Desktop System is less susceptible to virus and worm attacks due in part to a superior security architecture and the use of Java technology that confines actions to a restricted sandbox(http://www.oracle.com/us/products/031013)

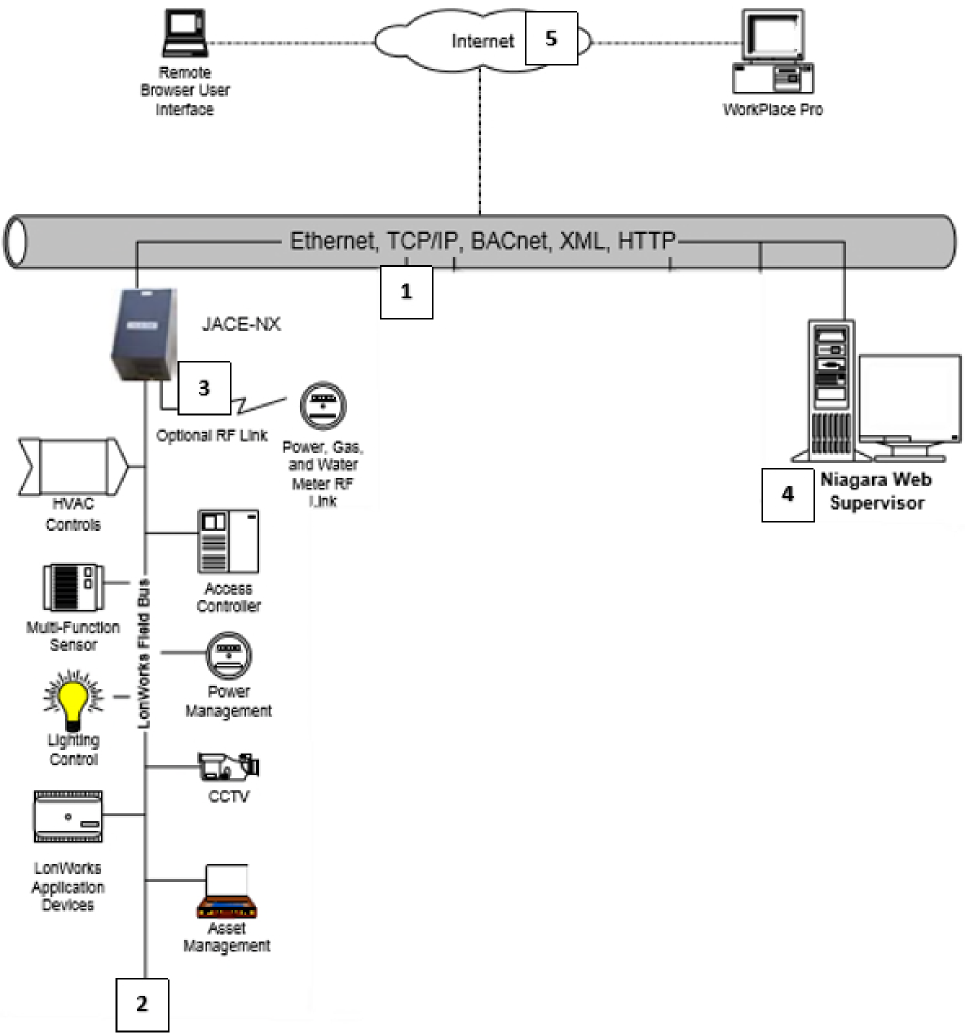


Figure 9 Re-engineered Distributed Automated System Architecture (extracted from Tridium, 2011)

6.3 Future Agent Interactions

As part of evaluating and optimizing a design solution, Figure 6 simulation was based on a simple exercise to define when each task should be executed and it also provided results that could be analyzed in order to choose an alternative path through alternate action blocks. However, for a next phase agent-based system architecture Clymer identifies that agents will need to act without human intervention for example; the agents will decide for themselves when and how to interact with other agents and select the agents with whom it will collaborate. In relation to Figure 6, message event action blocks will be added and the agents will have the option of deciding which task to collaborate with based on input precepts, sending and receiving messages and changing internal functions. In reality agents in a multi agents system such as Web services for costing and energy analysis would communicate and collaborate with other agents in other systems to perform additional service i.e. SCM, CRM and BI. Once the design concept is specified with alternative concurrent process for each decision-oriented function and describe how each agent will be implemented and interact with the system then the architecture can be measured by its technical performance MOEs (Measure of Effectiveness – operational measures of success) and MOPs (Measure of Performances – system efficiency and resource utilization). The simulation data would be passed onto the Web service software engineer in order to create a multi-agent based service utilizing the Semantic Web based on existing ontologies languages such as OWL and inference rules to perform the autonomous tasks (generating new relationships) for designing sustainable energy efficient buildings in urban environments.

7 Conclusion

This papers main question related to whether Europe has the agile infrastructures, network systems and operational models for developing and maintaining smart grid applications for city districts and the capabilities of extending a Hyper Connected World through Internet of Things and Big Data. In order, to investigate this question challenges such as Europe's decarbonisation requirements and market prices of electricity were analyzed. The paper presented the E-Hub case study as an example of Agent-based technology that implemented smarter financial instruments that can increase investment in new technologies for city districts. The Energy Hub case-study illustrated the benefits of exchanging energy via grids (households, renewable energy plants, offices, businesses) between its members which represent both consumers and suppliers. The results showed how a business model featuring agent-based technology representing devices in the marketplace and Multi-Commodity Matcher (bidding process) in collaboration with an auctioneer agent produced prices where electricity demand and supply are equal. The AAIC case study illustrated the technological innovation provided by a Chinese company in developing an open-access wireless LAN infrastructure in the Netherlands. The business models presented highlighted how new technologies can provide more sustainable urban environments from a network service view point using Cloud-based services. To-date the EU-China collaboration directives have been well supported by Europe because of China's market size in relation to smart cities and smart grid Web software development. The paper identified that Chinese business models are featuring vertical integration strategies based on using Cloud-based software that allows them to control their supply chain. In order, for Europe to continue collaborating with China in respect to Smart Cities, Web service applications will need to become more pronounced.

Section 5 provided results on an OpEMCSS simulation model that defined operational sequences for tasks based on an integration model for SCM, CRM and BI systems. The simulated arbitrary time units highlighted the sequence of events required for an online energy and cost analysis design process. The next stage proposes the use of Cloud Computing and Sematic Web to interconnect each task and its associated Web-agent. The use of ontology languages would provide rapid response time scheduling to activate agents in their required sequences. The scheduling and invoking of immediate actions by multi-processors for exchanging information is a key attribute for sub-systems and their device controls that can be advanced using ontology languages (encoding of knowledge about specific domains).

Section 6 incorporated the European Union's perception that utilities and DSOs are facing new challenges in managing their grids by focusing on the use of multiprocessors and designing an architecture for embedded systems. This section also extracted concepts from Tridium's Niagara Framework and Vykon products (JACE Controllers) with BACnet Protocols. Section 4.2 had demonstrated the connectivity power based on HD Wi-Fi evolution (eLTE), heterogeneous networks and City Wi-Fi in relation to B2B2X Living Lab open Innovation Platform that allows developers to combine their mobile applications with any IoT device, open data source, open API or Cloud-based services. The information and reason provided in this case study assisted the authors in redesigning Tridiums Distributed System to match a hybrid approach capable of incorporating partial features of E-Hubs design and agent-based software technologies for costing materials based on an energy analysis. The benefits of shifting to such a model has the potential for agents to communicate and collaborate autonomously in a multi-agent system. Europe has the capabilities to lead the world in smart grids applications but the European energy and security market needs an integrated electricity system to fully develop the potential of IoT.

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Towards a better, stronger and sustainable built environment

Aims and scope

Today's design strongly seeks ways to change itself into a more competitive and innovative discipline taking advantage of the emerging advanced technologies as well as evolution of design research disciplines with their profound effects on emerging design theories, methods and techniques. A number of reform programmes have been initiated by national governments, research institutes, universities and design practices. Although the objectives of different reform programmes show many more differences than commonalities, they all agree that the adoption of advanced information, communication and knowledge technologies is a key enabler for achieving the long-term objectives of these programmes and thus providing the basis for a better, stronger and sustainable future for all design disciplines. The term sustainability - in its environmental usage - refers to the conservation of the natural environment and resources for future generations. The application of sustainability refers to approaches such as Green Design, Sustainable Architecture etc. The concept of sustainability in design has evolved over many years. In the early years, the focus was mainly on how to deal with the issue of increasingly scarce resources and on how to reduce the design impact on the natural environment. It is now recognized that "sustainable" or "green" approaches should take into account the so-called triple bottom line of economic viability, social responsibility and environmental impact. In other words: the sustainable solutions need to be socially equitable, economically viable and environmentally sound.

IJDST promotes the advancement of information and communication technology and effective application of advanced technologies for all design disciplines related to the built environment including but not limited to architecture, building design, civil engineering, urban planning and industrial design. Based on these objectives the journal challenges design researchers and design professionals from all over the world to submit papers on how the application of advanced technologies (theories, methods, experiments and techniques) can address the long-term ambitions of the design disciplines in order to enhance its competitive qualities and to provide solutions for the increasing demand from society for more sustainable design products. In addition, IJDST challenges authors to submit research papers on the subject of green design. In this context "green design" is regarded as the application of sustainability in design by means of the advanced technologies (theories, methods, experiments and techniques), which focuses on the research, education and practice of design which is capable of using resources efficiently and effectively. The main objective of this approach is to develop new products and services for corporations and their clients in order to reduce their energy consumption.

The main goal of the *International Journal of Design Sciences and Technology* (IJDST) is to disseminate design knowledge. The design of new products drives to solve problems that their solutions are still partial and their tools and methods are rudimentary. Design is applied in extremely various fields and implies numerous agents during the entire process of elaboration and realisation. The International Journal of Design Sciences and Technology is a multidisciplinary forum dealing with all facets and fields of design. It endeavours to provide a framework with which to support debates on different social, economic, political, historical, pedagogical, philosophical, scientific and technological issues surrounding design and their implications for both professional and educational design environments. The focus is on both general as well as specific design issues, at the level of design ideas, experiments and applications. Besides examining the concepts and the questions raised by academic and professional communities, IJDST also addresses the concerns and approaches of different academic, industrial and professional design disciplines. IJDST seeks to follow the growth of the universe of design theories, methods and techniques in order to observe, to interpret and to contribute to design's dynamic and expanding sciences and technology. IJDST will examine design in its broadest context. Papers are expected to clearly address design research, applications and methods. Conclusions need to be sufficiently supported by both evidence from existing research (reference to existing design research knowledge) as well as strong case-studies from any design discipline. A paper must contain at least one chapter on research questions, methodology of research and methods of analysis (the minimum length is 1500 words). The concluding chapter (the minimum length is 1000 words) will summarise the paper and its results. The concluding chapter also examines and discuss applications, advantage, shortcomings and implications of the investigation for both professional and educational design communities as well as for the people and the society. Also authors are also encouraged to include in this chapter a discussion of the possible future research that is required or is possible in order to enhance the research findings.

The papers considered for IJDST cover a wide range of research areas including but not limited to the following topics: Design research, design science, design thinking, design knowledge, design history, design taxonomy, design technology, design praxeology, design modelling, design metrology, design axiology, design philosophy, design epistemology, design pedagogy, design management, design policy, design politics, design sociology, design economics, design aesthetics, design semantics, design decision-making, design decisions, design evaluation, design sustainability, design logic, design ontology, design logistics, design syntaxis, design ethics, design objective, design responsibility, design environment, design awareness, design informatics, design organization, design communication, design intelligence, design evaluation, design education, design theories, design techniques, design methods, design operations, design processes, design products, design users, design participation, design innovation, design inspired by nature, design case studies, design experiments, etc.

The *International Journal of Design Sciences and Technology* is devoted to further exploration of all themes and issues that are directly or indirectly relevant to the exploration, introduction, discussion of design sciences and technology, cross referencing domains and any other themes emerging in the future.

Instructions for Authors and Review Process

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[3] **Buxton, W** (1997) Living in Augmented Reality: Ubiquitous Media and Reflective Environments. In: Finne K, Sellen A and Wilber S eds, Video Mediated Communication, Erlbaum, Hillsdale NJ, 363-384

[4] **Dixon, NM** (2000) Common Knowledge: How companies thrive by sharing what they know, Harvard

Business School Press, Boston, MA
[5] **Djenidi H**, **Ramdane-Cherif A**, **Tadj C** and **Levy N** (2004). Generic Pipelined Multi-Agents Architecture for Multimedia Multimodal Software Environment, Journal of Object Technology, 3:8, 147-169
[6] **Gorard, S** and **Selwynn, N** (1999) Switching on to the learning society? Questioning the role of technology in widening participation in lifelong learning, Journal of Education Policy, 14:5, 523-534
[7] **World Bank** (2002) Social assessment as a method for social analysis, World Bank Group [www.worldbank.org/gender/resources/assessment/samethod.htm]

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