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# Intelligent Energy Management in cities

**"How to transform the urban energy chain"**

## Introduction

Our world is changing, and as a result of continued urbanization, cities are playing an ever-greater role as the new 'units of change'. Cities have become the defining places where we will deal with the cost, availability, and finite nature of natural resources; with emissions and compliance; and with climate change. This is a set of progressively developing and intrinsically linked challenges, towards which action must be accelerated.

At the same time, cities are at risk from overcrowding and the security of basic utilities, as well as pollution and natural or manmade disasters – all of which are closely linked with energy, a basic 'lifeline'. A city's resilience depends on its ability to protect lifelines such as energy, water, transport and communications. The Haiti earthquake of 2010, Hurricane Sandy, and the Fukushima disaster are just a few reminders of what happens when these lifelines are cut — and emphasizes what is required to rebuild them.

Unless major changes are made in how we consume, conserve and generate energy, a crisis looms. This is now broadly accepted right across the political, social and economic spectrums. Conversely, securing city lifelines allows cities to do what they do best: to provide a place for innovation, economic growth, and wealth creation.

This paper looks at energy in more detail and sets out how technologies that are widely available and affordable today can significantly impact urban energy management. We explore how technology can help transform and safeguard the energy chain by providing ways to ensure a more affordable supply.

> *"There are big challenges in energy that need intelligent solutions, and they are needed fast."*
>
> **Günther Oettinger,**
> EU Commissioner for Energy,
> May 2013[1]

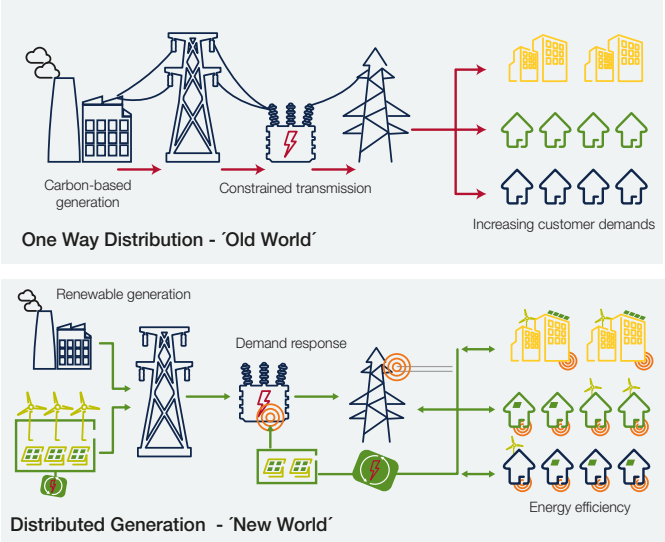
## Creating a bi-directional energy chain

Three fundamental drivers come together to impact the energy chain:

1. Cost to the end-user (household and commercial) is of growing concern.
2. New technologies and the growth of renewables change the dynamic of the whole energy chain.
3. There is a growing recognition that we cannot hide from resource depletion.

Our current energy chain has been built to operate in one direction – from source to consumer. How, then, do we change a one-directional energy chain to operate in two directions? How do we best introduce new alternative energy sources? How do we enable the consumer to make informed choices and change consumption habits? Which policies, which practices, which actors, and which economics and incentives will help change things? How can information and technologies help? And what role does City Hall play in the whole process?

Figure 1: From a one-directional to a bi-directional energy chain




Given that urban centers account for 75% of energy consumption worldwide and 80% of greenhouse gas emissions , there is no escaping the fact that cities must be the starting point for change. And, when we consider that upwards of 40% of all energy consumed is in buildings, it becomes clear that city buildings are a foothold for change.

"City Hall" can play a vital role in this change: as an *owner* of multiple properties and assets; as an *influencer* of its own staff; as a *convener* of (big) business consumers; as a *setter* of rules (policy and, at times, regulation); and as a *representative* of the voting public.

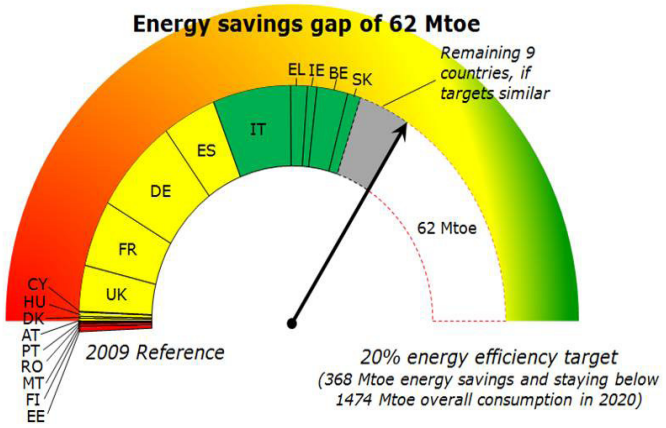
1 http://europa.eu/rapid/press-release_SPEECH-13-432_en.htm

2 Report: European Green City Index: Assessing the environmental impact of Europe's major cities, Economist Intelligence Unit and Siemens, 2009

## Technology: a wind of change through Europe?

We see ever-increasing action in response to the challenges set out above and it is clear that there is no single, simple answer. For example, the European Union has set ambitious objectives for the year 2020 to lower energy consumption by 20%, lower CO2 emissions by 20%, and ensure that 20% of energy is generated using renewable resources. It also requests that the public sector – with numerous civic, commercial and residential buildings in its care – leads by example, and demonstrates to citizens and to businesses that energy use can and must be reduced. Thus, acknowledging that City Hall must become the exemplar *and* the influencer.

Figure 2: The EU´s energy savings gap[3]



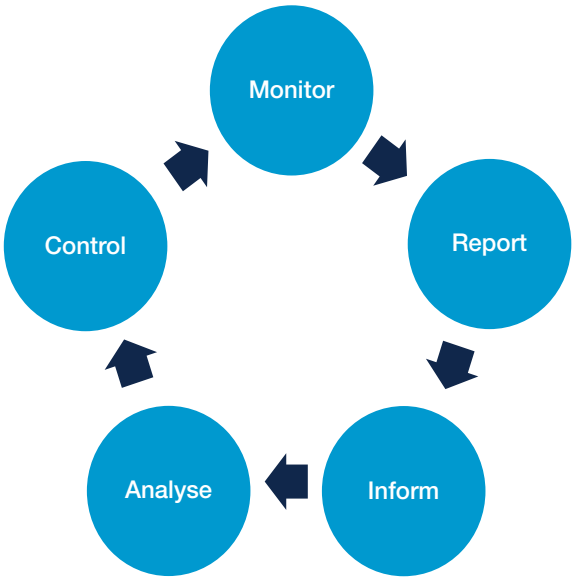

Europe's major cities, Economist Intelligence Unit and Siemens, 2009

To date, however, the EU is off track to meet its 2020 energy saving targets. There are still substantial improvements to be made, in order to harness a collective action which will result in not only realizing the EU targets, but in an enlightened approach to energy consumption and conservation. Individual and collective behaviors will play a huge part, and increasingly we see information and technology as being pivotal to enabling and sustaining this change.

New approaches and technologies can help to monitor energy flows in a more streamlined and efficient manner. They can ease the reporting burden. They can inform business leaders and household consumers so that they can take action. They provide analytical and controlling platforms to reduce consumption.

Yet our collective response is all too slow. It will take greater visible recognition from leaders of the need and the potential to change. And it will take a collective change in behaviors of us as consumers.

Figure 3: The data to change cycle




The as-yet-unfulfilled ambitions of Europe are reflected in many other nations worldwide. Yet there are actions at a different level: in cities and city-regions.

## Pockets of excellence at a city level

Some cities have already started to take the lead. For example, Washington DC began to retrofit 7,800 residential housing units owned and managed by the DC Housing Authority for more economical energy consumption in 2004. Fast-forward to 2013, and 5,400 units have been retrofitted, resulting in annual electricity, operations and maintenance savings of EUR 4.6[4] million. The benefits are manifold and sustained: cost savings for the Authority; more economical, warmer homes for residents; and a valuable, living example of the benefits of energy conservation through which to spread the message.

And success is apparent in other cities, often at district or community level. In Stockholm's Hammarby development major steps have been taken to embed energy conservation in the building design - enabling energy frugality from the start – and to draw the community into the dialogue as active participants.

3 http://www.europeanclimate.org/index.php/en/news/114-indicative-national-energy-targets-fall-short-of-2020-target

The Gapometer illustrates the contribution of indicative national energy efficiency targets (expressed in primary energy consumption in 2020) to closing the gap to the EU target, compared to latest available EU projections for 2020, including policies and measures in place by the end of 2009 (PRIMES published 2010).

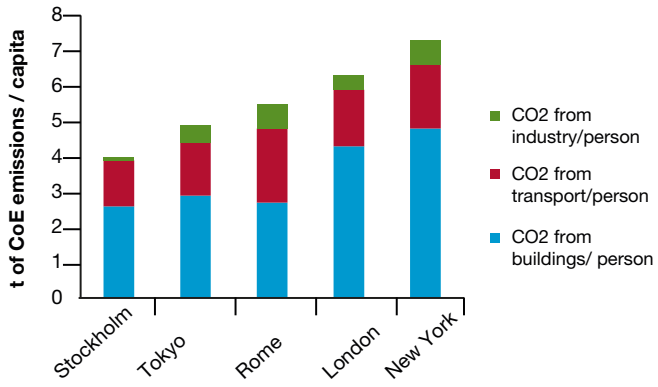
4 Exchange rates based on ECB rates, October 2013

5 Wealthier, Healthier Cities: How climate change action is giving us wealthier, healthier cities, 2013

According to a recent CDP report[5] across 110 cities surveyed globally, the most common energy efficiency focused activity undertaken by cities is to reduce energy demands in buildings. Not only is this economically preferable (for instance, London's city agencies are now charged Carbon Reduction Commitment tax, based on tones of CO2 emitted, totaling an estimated cost of EUR 14 million[6] per year which they would surely rather reduce), but it is increasingly viable, with a smart approach. That approach sees technology play a major role, along with strong alignment of stakeholders and a drive to change behaviors.

We see in the following graph, for example, that London's buildings CO2 emissions are half as much again as that of Stockholm, despite the fact that the latter has a far more severe climate. As well as demonstrating relative progress among major cities, this highlights what is possible. If Stockholm can reduce buildings CO2 emissions in the face of harsh, dark winters, what, in time and with the right technology, can London achieve?

Figure 4: Per capita CO2 emissions by city (2005 or most recent available)




Source: EU Directive on Energy Efficiency, Siemens "Sustainable Urban Infrastructure, London edition"

## The contribution of business

But it's not just City Hall that must drive this change. Businesses, large and small, have a vested interest in reducing their energy consumption – and can realize important benefits. By decreasing energy use and lowering emissions, not only will savings be made, but sustainability commitments can be met. This feeds into the citywide ambition for change.

## Different cities, different approaches

**Copenhagen** ranked best in Europe out of 120 cities worldwide in the 2012 Siemens and EIU report, *The Green City Index*. The Danish capital has set out its ambition to become carbon neutral by 2025, and aims to achieve 10% of its carbon reduction through addressing construction and existing buildings - upgrading municipal buildings for maximum energy efficiency, for example. Copenhagen's residential buildings are among the index' lowest consumers of energy, across the entire Index.

The City of **Berlin** has partnered with the Berlin Energy Agency to create an energy-saving model, the 'Berlin Energy Saving Partnership'[7]. The focus is on the refurbishing of public and private buildings to optimize energy efficiency. A key motivator is that the owner is not asked to provide investment, yet can realize cost savings almost immediately. From 1,300 buildings already retrofitted, savings of €10.5 million have been seen. It is estimated that carbon emissions have reduced by more than 600,000 tones.

**New York City**[8] is using a data-driven approach to reduce municipal greenhouse gas emissions by 30% by 2017. First, the city is using its benchmark results and other data sources to prioritize energy efficiency projects and monitor building performance over time. Another component, the Greener, Greater Buildings Plan, is the implementation of energy audits and cost-effective retrofit measures as well as the identification of clean DG opportunities. Next, these retrofit efforts are tied to improved operations and maintenance as well as retro-commissioning. Finally, the city analyzes the energy performance results regularly. Future year-to-year analyses against benchmark baseline scores will allow the city to identify the impact that factors such as efficiency investments, building management and occupant behavior have on energy use.

## Addressing the inhibitors

We see cities and businesses starting from varied positions. Some have seen encouraging progress already, whereas others are struggling to gain traction. There are numerous factors stalling progress, including:

- **System complexity:** What are we trying to change? Will it make a difference? How can we quantify the difference and be assured of realizing benefits as a result?

7 http://www.c40cities.org/c40cities/berlin/city_case_studies/energy-saving-partnership-berlin-esp-%E2%80%94-an-effective-and-innovative-model-to-reduce-co2-and-energy-costs-without-expenses-for-building-owners

8 http://www.c40cities.org/c40cities/new-york/city_case_studies/new-york-city-government-leading-by-example

- **People:** Which of the multiple stakeholders drives this change? Will we succeed in aligning people? How can behaviors be changed? What is the role of City Hall in changing behavior?
- **Financing:** Who funds this and how? What is the motivator for doing so? How best to make public/private funding work?
- **Business model:** What if this doesn't fit with our current business or operating model? Can we retrofit it?

Any transformation demands that these kinds of searching questions are posed and answered. And as the answers emerge, so does a roadmap for change. But whether the journey has started in earnest, or whether an organization or a city is still charting its future path, what will be true in all cases is the need for a framework that sets out how to make change happen.

We see four key elements that play important roles within that framework:

1. The ability to inform and **shape demand** so that energy is consumed when there is sufficient and affordable supply (and not vice versa, as is the case under the current paradigm); so that peak demand is reduced
2. **Physical devices** or gadgets, ranging from smart meters that measure energy consumption in real time to smartphones and in-home devices (IHDs) that make it easy to access data
3. An **information platform** which connects devices, from which progress can be measured, benefits can be pinpointed, financials are tracked and through which the necessary stakeholders are aligned
4. Integration of **alternative** (renewable) **energy sources**, as well as **new consumption and storage devices** such as the batteries of electric vehicles.

By getting practical, and by embracing technology as a way of collecting, aggregating and analyzing data, significant strides towards smarter energy consumption can be made.

It's all part of the journey to help make our cities smarter: more innovative, knowledgeable, connected, and using ICT to advance economic growth in a socially inclusive and sustainable way.

## Nudge or shove?

**How the drive for behavior change toward energy conservation has succeeded around the world**

Regulatory change is designed to change organizations' and peoples' behaviors. This is key in the energy domain where shaping demand is vital—and where demand needs to fit in with the increasing supply of intermittent renewable energy.

### Smart meters and the power of information

A 2011 report by VaasaETT, a global energy think tank, reviewed around 100 feedback and dynamic pricing pilots for households enabled through smart metering technologies. Compared to other feedback channels (e.g. websites, regular bills) IHDs (in-home devices) delivered the highest energy savings. However results vary widely within a given program type; an IHD pilot can attain 3% or 19% reductions.[9] So while technology is clearly an important enabler (e.g. for an IHD that displays energy consumption data that is relevant to the user, in an easy to understand format), other variables have a substantial impact on program success as well.

### Using technology to go further…

One U.S. company has successfully collaborated with the regulatory authority to impact behavior of customers and of utility workforces in parallel. And they are using "fun" as their currency.

California-based Vergence Entertainment, in association with multiple utilities and funded in part by a grant from the U.S. Department of Energy, developed an engagement and education platform called ASK, which uses social and game mechanics to engage people in developing new habits. The ASK platform recently tested and deployed an incentivized education program branded as Play-Learn-Win. The program has succeeded in sustaining daily engagement over multiple months, while delivering graduating levels of change-based curriculum.

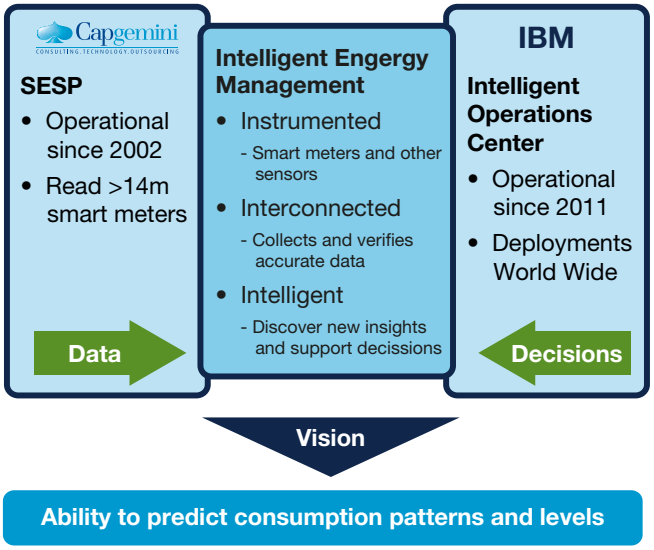
Recent trials in multiple states provided six-month efficacy results. The ASK platform delivered education across a span of customer demographics. The curriculum consisted of tips and actionable insights on efficiency, conservation and dynamic pricing topics. The trials measured knowledge gain and skill retention, collected engagement metrics and third-party reporting of customer changes, including improvements in attitudes, and behavior impacts ranging from programming the thermostat to in-home projects such as sealing, installations and shifting times of use. Daily data shows sustained averages of over 20 minutes monthly of customer interactivity, amounting to over 30 energy-related decisions made by the customer each month.

What these examples have in common is recognition that ease of access to a service or scheme is crucial for its success – the user involvement and experience is a vital factor in capturing "hearts and minds" and ultimately, changing how people think and act when it comes to energy consumption.

9 http://www.esmig.eu/press/filestor/empower-demand-report.pdf

Figure 5: The data to change cycle


Figure 6: Intelligent Energy Management - Solution Overview" or "IEM - Solution Overview




## The road ahead

The challenge to cities to lead the way in driving a new and more sustainable energy chain has been set. The EU´s 2020 targets, and those in other countries are now generally in place and signify a stark reality, requiring immediate and collective action.

So, where do cities, city agencies and corporations go from here? How can they start to put in place the technology, processes and levers to affect a measurable change?

The way ahead demands a roadmap that incorporates the five vital tenets of smart energy management: monitor, report, inform, analyze, control.

From here, great strides can be made.

## Our Case for Action

### The Intelligent Energy Management (IEM) Platform

Capgemini works with physical and virtual cities, businesses and organizations who manage large building portfolios, helping them to manage their energy more intelligently. We also bring decades of experience in overall utility systems.

We draw on this, as well as our partnership with IBM® and their IBM Smarter Planet® initiative, to deliver Intelligent Energy Management (IEM) solutions. This solution combines Capgemini´s tried and tested Smart Energy Services Platform (SESP) for accurate data with the analytical power of the IBM Intelligent Operations Centre (IOC).

IEM is **instrumented** – using smart meters and other sensors; **interconnected** - collects and verifies accurate data; and **intelligent** - discovers new insights and supports decisions.

Our IEM solution combines Capgemini and IBM technology; SESP *monitors* smart meters and other intelligent sensors, collects flow readings (electricity, gas and water), verifies their accuracy and delivers real time data. The Intelligent Operations Center (IOC) uses the real time data against defined KPIs and adds advanced real-time *analytics* and *reporting*; our vision is to predict consumption patterns and levels accurately, based on parameters such as occupancy rates, weather forecasts, or production levels.

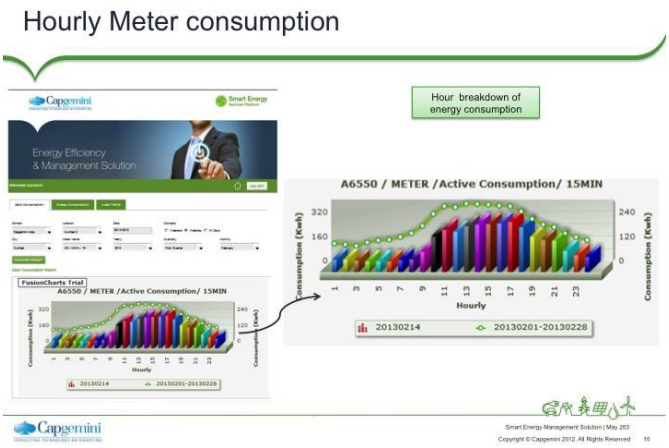
IEM has delivered a **15% reduction in energy consumption, and also reduced the cost of environmental and management reporting** – a process that is mandatory in many countries for tax and compliance reasons. IEM enables **better decision making**, as it is based on **more accurate data** and uses **better and more timely analytics**. Finally, our IEM solution is **low risk** – it is cloud-based and can be **deployed rapidly**, with **low complexity** and **minimal impact** on existing systems. We offer it as a 'rented' service – low entry costs; swift start-up; with rapid value potential.

We have put our platform into practice in India, where Capgemini has multiple physical sites (25 sites supporting over 41,000 resources), together with smart metering ('gadgets'). There is a strong desire to drive down energy consumption in order to meet our sustainability commitments – as well as realize savings. Altogether, a proven and real test case.

The system was rapidly deployed (operational within six weeks) and hosted in the cloud. Data was captured and reported, to a degree of granularity which was not previously possible. The business benefits were fourfold:

1. **Reduced energy wastage:** wastage was swiftly identified and halted – covering both Capgemini and third party suppliers working on-premises. For example, third parties energy consumption was monitored and issues identified were addressed promptly. Without the platform, such issues had not come to light.
2. **Smarter operations became 'business as usual'**, making tangible improvements to the ambient temperature of buildings, for example. We were able to match air conditioning requirements more closely to the use of building areas by monitoring electricity load, and in some cases, drastically reduce un-needed or ineffective HVAC use.
3. **Reimbursement of third-party consumption** became possible through the use of the Smart Energy Management Platform. Sub-metering of vendor base stations, for example, could be carried out accurately, and actual energy costs recovered.
4. **Better decisions** could be made, with the abundance and accuracy of the data provided by the platform. Comparative efficiency of different systems for heating, for example, could be measured like-for-like, providing valuable input to future decision-making.

Figure 7: Example screenshot - IEM




## Benefit within weeks

The Intelligent Energy Management solution can be implemented and operational within weeks, getting cities on the road to better energy management, and to rapidly experiencing the associated benefits.

With critical targets to be met and an ever-emerging sense of what is at stake, the journey to 2020 is underway. Are you onboard?

## Why Cities and Businesses Need to Act

- Despite a milder climate, carbon emissions from London buildings are nearly 50% above Stockholm's. And London's Climate Change Action Plan calls for a reduction in CO2 emissions by 60% by 2025
- The quantity of renewable energy produced within EU countries increased by 72.4 % between 2000 and 2010, despite accounting for only 11% of energy consumed in 2009[10]
- Worldwide CO2 emissions rose by 1.4% to 31.6 billion tons in 2012 – reaching a record high, according to the International Energy Agency
- According to the CDP Cities 2013 report, 39 cities reported increased efficiency of operations as a result of responding to climate change.[11]

10 http://www.erec.org/statistics/res-share.html
11 http://www.cdpcities2013.net/#!/opportunities/p/5/

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