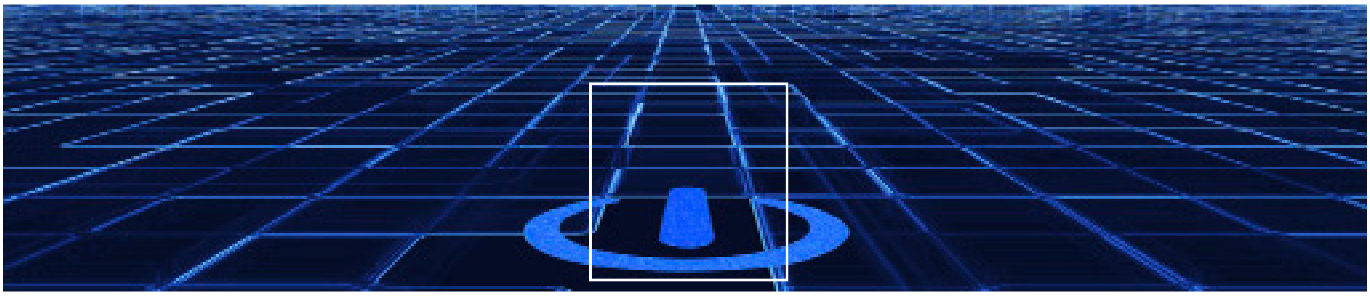
Where's the Money in Smart Grid?

Smart Grid offers established and new players business models in the energy market of the future



Existing power grids will not be able to meet the increasing demands for a reliable energy supply for much longer. The growing proportion of decentralised energy generated through renewables is making power transmission and distribution increasingly complex. At the same time, the current grid infrastructure, which dates from the middle of the last century, is reaching its capacity and quality limits. A "Smart Grid" that combines innovative information and communications technologies with classic energy components will allow intelligent and highly automated network control and maintenance. Established and new players in the energy market are in the starting blocks ready to enter the race to achieve a share of the Smart Grid market.

Risks and challenges of the German power grid

The German power grid has until now been considered the best in the world for network quality. However, the increase in the average power supply interruption period per customer from 15 minutes in 2002 to 19 minutes in 2007 demonstrates the emerging risks that the ageing power grid poses. From an economic point of view power failures are associated with significant costs. For example, the losses arising from the shutdown of the entire German power distribution network for one hour on an average working day has been estimated to be between €600–€1,300m.

Furthermore, until recently, energy has been supplied to consumers through large central power generation units and with a uni-directional load flow. However, the requirements of a modern power supply are changing. Integrating energy generated through renewables and the subsequent increase in fluctuation of feed to the grid represents a major challenge and stretches the current infrastructure to the limit of its qualitative and quantitative capacity. This is the challenge an intelligent power grid will have to meet

Smart Grid – the answer to growing risks and challenges

To meet the increasing demands on a modern power supply it is necessary to connect electrical power grids with modern information and communication technologies to create an intelligent system that can secure an effective balance between power generators and consumers: the Smart Grid.

Features of a Smart Grid

An intelligent grid must offer a variety of features in order to meet the increasing demands on the grid infrastructure:

- Incorporation and integration of renewable and decentralised power generation
- Integral energy data management
- Mastery of fluctuating power feed into the grid
- Integration of load-remote generation
- Integration of distribution grid automation, metering and asset management in one infrastructure
- Integration of options for energy storage (including E-cars)

The primary goal is to secure grid stability in the face of constantly changing framework conditions. Arthur D. Little estimates that investment of €80–100 billion in Europe's power distribution grids is necessary in order to allow the use of Smart Grid technologies across the whole continent.

Smart Grid approaches to securing grid stability

Smart Grid opens up the possibility of using many levers simultaneously to secure grid stability. On the one hand, it is possible to incorporate energy storage technologies to circumvent the otherwise necessary synchronisation of generation and consumption. On the other, shifting consumption or generation can be achieved by using load management. The main focus for load management in the past has been on shifting demand out of peak load times. In future, unplanned production peaks resulting from decentralized energy generation will make synchronizing consumption with these peaks the goal (see Figure 1).

It is important to differentiate between incentive-based and active load management. With incentive-based load management consumers are given an incentive via a price signal at the power socket to switch on devices outside peak load periods or to have their devices switched on automatically using an accessory for the device.

With active load management the supplier switches devices on and off within defined framework conditions. This provides the energy supplier with a range of options for designing products, from time-variable tariffs during peak load periods through to real-time pricing.

Load management in the domestic setting (B2C)

The electrical devices used in private households can be divided into three categories: devices whose load cannot be shifted, devices whose load can be shifted to some extent and devices whose load can be shifted unconditionally.

Devices whose load cannot be shifted include televisions, lights and electric ovens. Those whose load can be shifted to some extent include washing machines, although shifting the load may restrict the consumer's use of the device. The household devices that offer the greatest potential for load shifting make use of the inertia of thermal systems. In the case of refrigerators and freezers, for example, the load shift can be performed within defined time periods without the consumer's use of these device being limited. Refrigeration equipment includes air conditioning units, the widespread use of which offers great potential for load management, particularly in the USA.

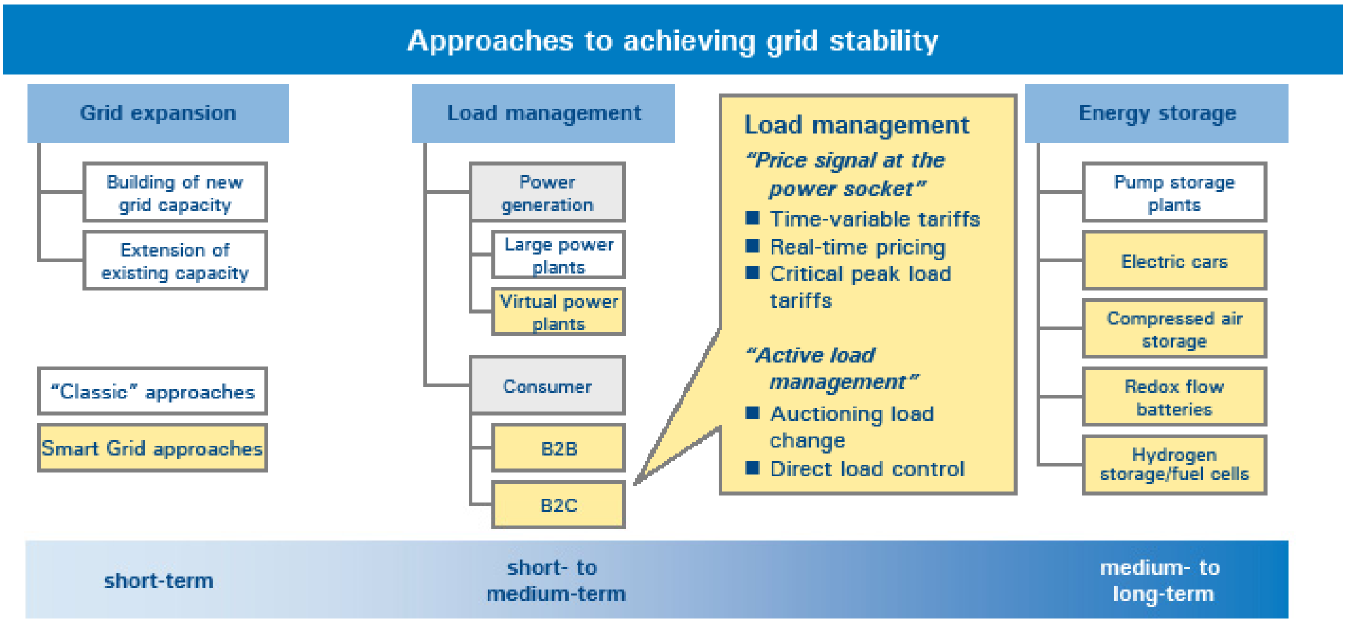
Arthur D. Little estimates that when all German households are taken into account, load shifting can deliver about 1.8 GW of regulated energy. Of this, about 60% comes from refrigerators and freezers alone since these qualify for unconditional load shifting. Household devices whose load can be shifted to some extent, such as washing machines and clothes dryers represent a high load in German households but are not suitable for load management since switching these devices on and off every 15 minutes would have a negative impact on functionality.

Regulated energy for electric car batteries

One further option for regulating unplanned generation surpluses or deficits to support grid stability is the use of energy storage systems. At times when demand is low, excess energy is stored temporarily with the aid of storage technologies in order to make this available again when demand exceeds supply.

Pumped storage plants are already incorporated into load management systems. Pump storage capacity in Germany is about 6.7 GW. The greatest potential for regulated energy is expected to come from electric cars running on batteries. The German government aims to have one million registered electric vehicles in Germany by 2020. Arthur D. Little calculates that one million electric vehicles will create a potential 5.5 GW of regulated energy.

Figure 1: Approaches to secure grid stability



Business models

As the Smart Grid develops, framework conditions and the business models and positioning of established market participants will change.

One approach organisations can use to develop a Smart Grid strategy is to evaluate the different business models for their market attractiveness as well as the organisation's ability to master the primary success factors. Ability to master the success factors differs significantly from sector to sector and thus represents a useful starting point for new market participants assessing their capacity for success in the energy market (see Figure 2).

New business models are expected to emerge, particularly in the areas of invoicing, load management and merging to create virtual power plants.

Invoicing services in the industrial energy market, for example, are currently characterised by a single annual calculation of energy used, based on a meter reading. This calculation becomes the basis for future payments. Use of "smart meters" that measure usage every fifteen minutes will increase the volume of data for processing significantly. In the domestic arena, for example, data volume is expected to increase 35,000-fold.

Invoicing for electric vehicles will place new demands on the data processing systems of the service providers too. New invoicing systems for electric vehicles that calculate and charge for power consumed during a charging process, through credit card payments for example, may be relatively simple, but when electric vehicles are part of an energy storage system and thus a provider of regulated energy invoicing becomes significantly more complex. The positive and negative regulated energy provided by the vehicle during the charging process must be invoiced appropriately. If a vehicle finds itself outside the grid area covered by its contractual power supply partner then an invoicing system which is independent of location must be used – a kind of *"current roaming"* – which in turn involves accounting taking place among the various grid operators or power suppliers.

In this way the demands on successful invoicing business models increase. The primary success factor in this case is the ability to provide IT systems that can manage both simple and complex accounting processes economically and accurately. Analogies with the telecommunications market in terms of the necessary infrastructure and accounting processes show that it is in this market segment in particular that telecommunications companies can be expected to make an entry.

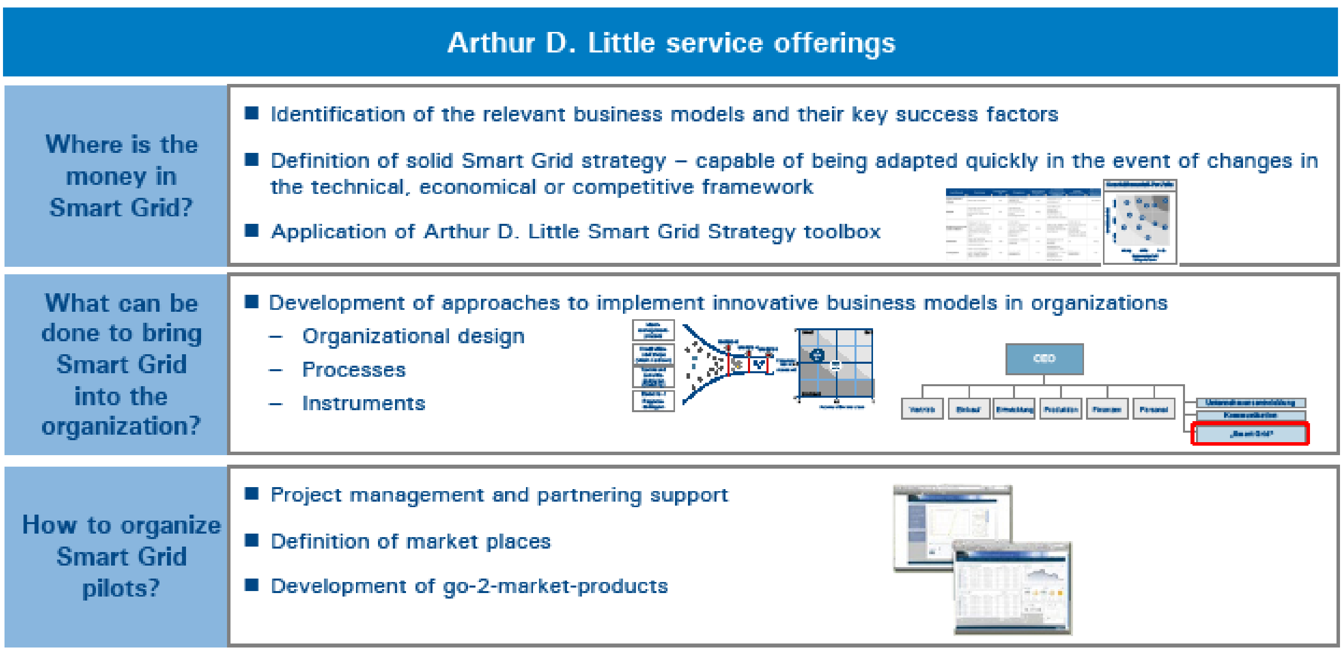
Companies intending to invest in Smart Grid business models have three options for growth:

1) Export technologies and business models that have been developed for the home market worldwide .

2) Increase existing market share in the national energy market through early acquisition of competitive advantage as a basis for building customer loyalty within the sector.

3) Combine products for the energy business with products from other sectors (e.g. combine power supply, telephony, mobile telephony, the internet and TV in a single invoice to achieve customer loyalty across a number of sectors).

Figure 2: The Arthur D. Little Future Grid building plan



Need to take action by the companies

The increased intermeshing of a traditional grid infrastructure with information and communications technologies and the ensuing change in traditional business models offers opportunities both for established players in the energy business as well as companies from other sectors. For existing energy providers the entry of new competitors into the market brings the risk of a loss of market share. The major challenges for all companies lie in three areas:

1. defining robust strategies that allow them to react early to changes in framework conditions for economic efficiency and to changing technology and regulatory requirements

2. finding opportunities to generate competitive advantage

3. identifying business model from which they can actually make money.

Individual companies can assess their own positioning against the various potential business models and relative market attractiveness with the aid of the Arthur D. Little *"Future Grid building plan"* – an important cornerstone for defining a Smart Grid strategy that goes beyond the standard running of pilot projects. The plan can help companies address key questions, including establishing at what level within the organisation responsibility for Smart Grid activities should lie, how Smart Grid projects and activity should be coordinated, and evaluating the need for change in the company's organisation and structure.

Arthur D. Little offers a range of organisational and process-oriented approaches to help companies anchor innovation development and implementation at the heart of their organisations.

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Arthur D. Little

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