Intelen
DATA ANALYTICS FOR ENGAGEMENT SOLUTIONS

Behavioral Dynamics for Building Analytics vol.1: Engagement

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Authors: Vassilis Nikolopoulos, PhD
CEO & co-founder

Kostas Staikos, MSc
CTO & co-founder

http://www.intelen.com
Contact: info@intelen.com

The outputs are already being applied to real smartgrid projects by Intelen

Introduction to the Social Grid for Building Analytics

Within global/EU residential and commercial buildings are responsible for about 40% of total energy consumption and the potential for energy saving by 2020 is estimated to be around 30% and 35% of energy use respectively. According to the EU Directorate-General for Research Sustainable Energy Systems, European electricity consumption is going to rise by 1.4% per year up to 2030 unless measures are taken. As a consequence, in residential and commercial buildings improved energy management systems are very important. Building Energy Management Systems (BEMS) and its variation Home Energy Management Systems (HEMS) are wireless and Web-enabled systems that integrate and monitor equipment such as HVAC, lighting, power, fire and security systems.

Currently, BEMS/HEMS technology facilitates the smart management of energy use, achieving energy efficiency through the scheduling of the operation of major equipment. However, they lack more sophisticated components that include real-time energy consumption and user energy consumption patterns and habits feedback; demand limiting, load shifting, and context-aware controls. These services require advanced (smart) meters that record and communicate actual electricity use in real-time and then adjust electricity use based on time-of-day, on peak/off peak or other situational conditions. The potential carbon savings and increase in energy efficiency through the adoption of such advanced control systems could be significantly improved.

In order to develop an advanced energy information system for a Building to perform analytics actions, several requirements have to be met:

- *Energy consumption data collection and management*. The system should support real-time or near real-time collection of energy consumption data and should support data management in the form of data aggregation, data structuring and transformation so as to feed other service layers in a generic way.

- *Bidirectional communication with the smart grid.* The system should support ***Energy Information Services - EIS*** to connect its energy control capabilities with a smart grid interface. On the one hand, such services can support the efficient energy distribution and production based on the knowledge of buildings energy requirements. For example, the collection and analysis of energy consumption, by meters embedded in the building, can be used by electricity providers to forecast the energy needs of their consumers and avoid energy shortages or blackouts. On the other hand, the energy control system can handle services provided by the smart grid, such as demand/response programs and time-of-use pricing that can be incorporated in the energy management policies defined by the consumer in order to optimize energy consumption and cost while satisfying user needs.

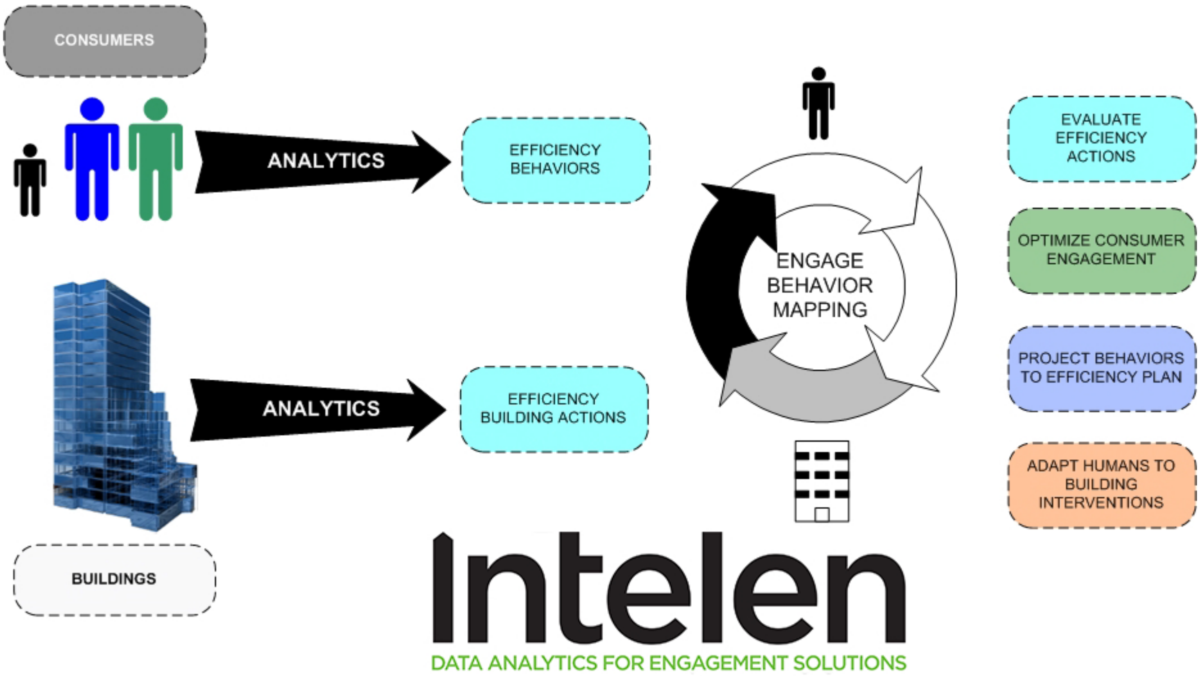
- *Interoperability.* Appliances and devices in a smart home should be accessed and controlled efficiently through a Home Area Network (HAN). However, the integration of appliances and devices, even if it is possible to achieve at the physical and communication layer (e.g., using power line communication, communication routers) still face problems at the application layer and the data semantics. For example, different appliances at the application layer may have different policies and rules to control energy management. Models and mechanisms to identify and handle conflicts between different policies are essential.

- *Intelligence and Insights.* The system should support ***intelligent energy-aware data analytics services*** beyond simple rule-based decision support. *Ambient Intelligence* (AmI) technologies use environmental context (e.g., temperature, humidity, light, etc.) and users' context (e.g., current location, activity, preferences) in order to decide the best energy management policy/action plan, while at the same time maintaining user comfort. A more advanced scheme will be the system to predict the users' behaviour by analysing the collected data to learn users' preferences and behaviours. After this learning process the system can optimize the control precisely to the requirements and preferences of its users and use the settings needed to reduce energy consumption. Complexities arise in terms of how the system performs when multiple inhabitants are present, each with different preferences and activities. To gain user's acceptance the system should support the residents, but it should not impose their actions. Therefore, it should be in a position to perceive the environment and be aware of the users and their activities, by learning and adapting its behaviour.

- *User interaction and motivation (Social behaviours)*. The system should provide users with proper support in terms of information feedback and motivation. Several studies have come to a conclusion that people are willing and c**apable to adapt their behaviour in the direction of saving energy on the account that they are provided with proper support**. The user interface should provide information about the current consumption and also previous consumptions, providing reports on a daily, monthly or annual basis. Additionally, it can offer the possibility to compare the electricity consumption between periods of time or even providing users with information on other energy users and peer groups who share a similar usage pattern (e.g., at a neighbourhood level).

- *Security, privacy and trust*. The system should provide mechanisms to ensure security, privacy and trust. Behind the reasons why previous systems for energy management and smart metering have failed or suffered a slow overall market adoption, there are some fundamental issues, among which, the threats to security and privacy (explicitly identified as controversial in the case of PowerMeter, GreenOS or some Smart Meters) are frequently considered the most important barrier to the acceptance of those systems. Security, privacy and trust are indeed essential aspects in any practical system affecting users' activities and their daily lives. Failure to protect the users' privacy and security would immediately disqualify otherwise good solutions for practical application.

Intelen's motto is that energy data analytics is able to "engage" humans towards smart decisions. Intelen is a service provider company that uses advanced game mechanics, behavioral engineering in order to develop systems and software for utility, auditors, contractors, retailers, commercial & industrial clients that monitors, analyzes and predicts energy consumption and determines the most cost-efficient energy efficiency measures.

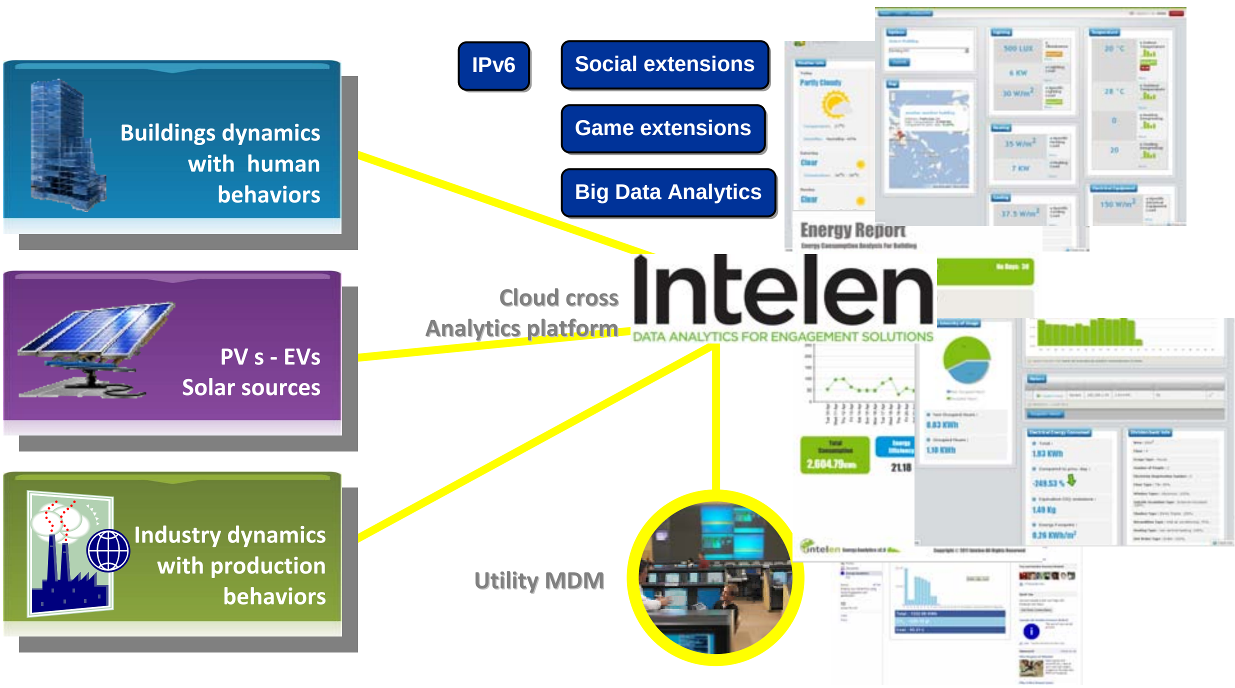


Intelen's approach to Social Energy Game Mechanics (SEGM)

Recently, Intelen was recognized as an **EU best practice** in eco-innovation by OECD @ http://www.oecd.org/sti/innovationinsciencetechnologyandindustry/49521648.pdf

Intelen's disruptive models for the use of social networks and real-time social game mechanics (over smart metering and stream data analysis to adapt game scenarios) for shaping energy demand and optimizing energy efficiency / savings using human energy behavioral dynamics, was among the recognized best innovation models in EU.

The disruptive model was first applied to the pilot project "thePowerOften – http://www.thepoweroften.gr" in ten schools in Athens (Feb – May 2011), achieving efficiency and savings over 38% in 10 weeks, by changing only social energy behaviors in real-time. The social network effect and specific Intelen social-power algorithmics over Web 2.0 smart metering, raised energy awareness among students and by entering in a real-time competition, they managed to reduce their energy consumption over 38% in average. Also, the same model won the World Smart Grid Innovation contest by Siemens in 2011 and is now being applied to various Commercial and Industrial customers in Greece and Cyprus. The total energy power savings for these 10 school units over a period of 10 weeks was 12.234 KWh. The calculated monetary benefit is 3.500€, when the electricity school price for energy unit is 0,12€ per KWh. The extrapolated power saving per school year (40 weeks) was 48,936 KWh.



Recent advances on energy metering and energy efficient equipments have been partially adopted in public and residential buildings. Informing the public, and especially the primary and secondary education community, about energy-efficient behaviour and the new energy-related technologies usually requires significant time, effort and resources, possibly more than the ones a typical organization is willing or able to spare. In addition, the financial benefit that is a determinant factor for the adoption of "green" technologies and best practices is also generally difficult to be accurately estimated and appreciated.

Consumer's behavior is an important factor that determines the overall energy consumption of buildings, and may be improved through energy awareness. Results reports indicate that energy-efficiency behaviors account for 51% and 37% of the variance in heat and electricity consumption between buildings, respectively. An energy consumer that is able to know in real time the energy consumption that his/her behavior is causing and compare it to that of other similar users is more likely to initiate changes. The term energy awareness implies the training of a user in terms of understanding how much his actions and his use of appliances contributes to total consumption, and helping him plan specific actions that could lower consumption in a quantifiable way

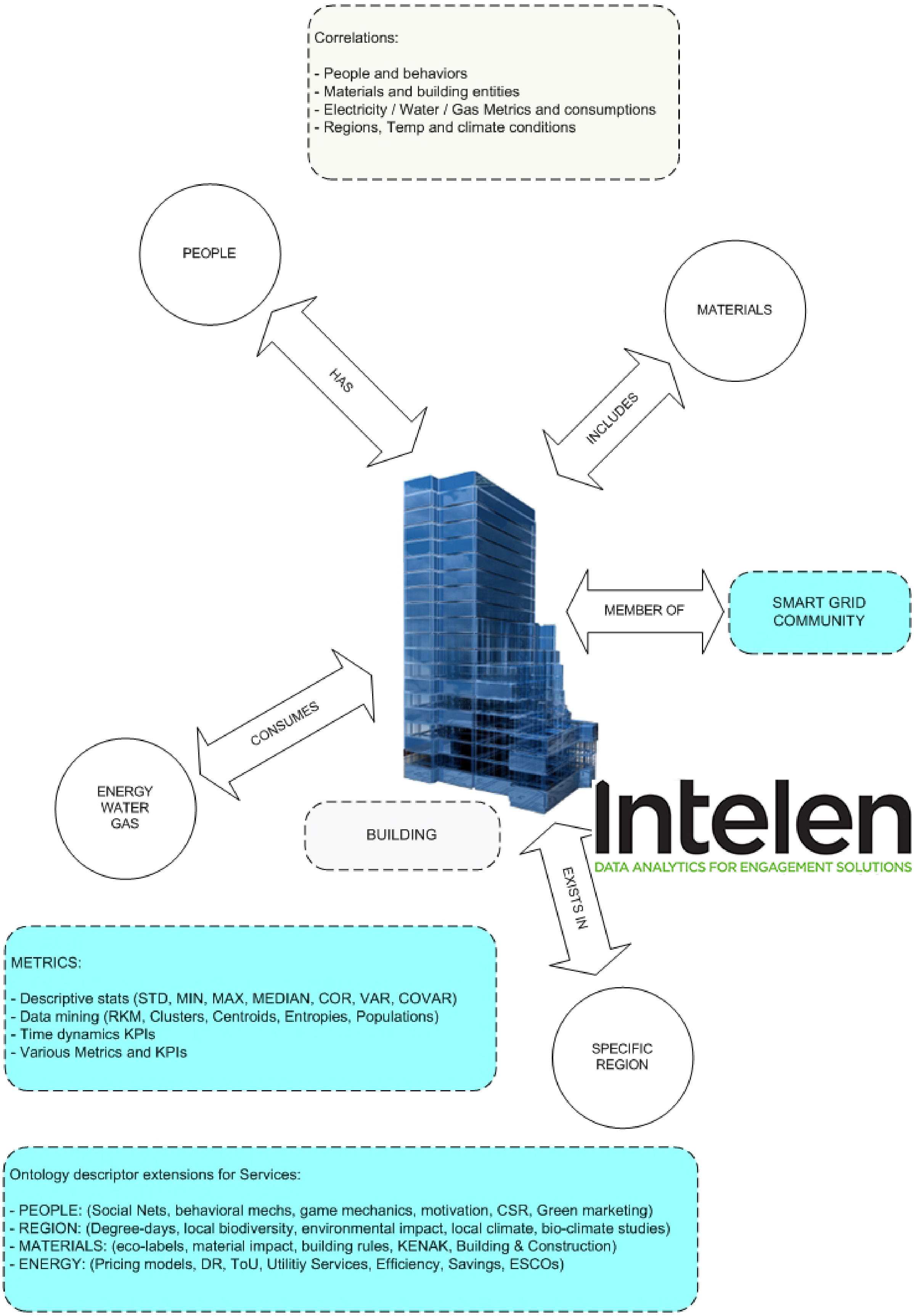
Intelen's plans and vision is to enhance its behavioral services portfolio and expand relevant Demand response and energy efficiency services to the home consumer market, using gamification approaches and social networks.

Motivation creation based on Captology principles for Efficiency and DR. Incentives and continuous game mechanics, will create motivation and by using Web 2.0 persuasive IT processes, consumers will develop a continuous engagement habit, towards energy efficiency and focused DR programs. The p[persuasion process of a consumer, using modern IT, Web 2.0 and computers, is called Captology.

And if this principle is applied to the energy efficiency services and DR, then social motivation can be triggered more efficiently. Modern Energy ICT systems can function as persuasive social-energy actors, persuading people to change their energy attitudes and energy behaviors by providing real-time information, modeling attitudes or behaviors, or leveraging social energy rules and dynamics.

Demand Response 2.0 services: by characterizing residential electric customers according to their energy management behavior and various KPIs, utility brands will optimize customer acceptance of and satisfaction with smart energy technologies. While customers in certain behavioral segments are keenly interested in knowing the amount of energy they use or how much money they can save by taking steps to conserve, customers in other segments want the opportunity to earn points for reducing energy use and to redeem their points for cash or merchandise.

This is where the social nets and specific game mechanics scenarios will enter


Correlations:
- People and behaviors
- Materials and building entities
- Electricity / Water / Gas Metrics and consumptions
- Regions, Temp and climate conditions
PEOPLE
HAS
MATERIALS
INCLUDES
MEMBER OF
SMART GRID COMMUNITY
CONSUMES
ENERGY WATER GAS
BUILDING
Intelen
DATA ANALYTICS FOR ENGAGEMENT SOLUTIONS
EXISTS IN
SPECIFIC REGION
METRICS:
- Descriptive stats (STD, MIN, MAX, MEDIAN, COR, VAR, COVAR)
- Data mining (RKM, Clusters, Centroids, Entropies, Populations)
- Time dynamics KPIs
- Various Metrics and KPIs
Ontology descriptor extensions for Services:
- PEOPLE: (Social Nets, behavioral mechs, game mechanics, motivation, CSR, Green marketing)
- REGION: (Degree-days, local biodiversity, environmental impact, local climate, bio-climate studies)
- MATERIALS: (eco-labels, material impact, building rules, KENAK, Building & Construction)
- ENERGY: (Pricing models, DR, ToU, Utilitiy Services, Efficiency, Savings, ESCOs)

Intelen's cloud system analyzes the real-time energy consumption and various dynamic statistical indices and metrics and at the same time another sub-module analyzes the behaviour of the same energy customer. Special algorithms and game mechanics / scenarios engage the user in a continuous game by offering energy efficiency services and personalized incentives to save energy and to follow DR signals / demand response programs. By using social competitions, social group benchmarking and social interfacing, the energy customers can interact with the service in real-time (as playing a game with real energy data) and the service offers adaptive incentives to the customer, according to his social profile and his habits (social behaviour).

Intelen's social energy services portfolio comprises of:

- effectively influencing the demand behaviour of consumers in order to achieve substantial reduction of energy (as well as CO_2) in their buildings,
- raising awareness of energy consumption and Demand response issues in building communities as well as for preserving available resources,
- identifying the energy saving potential of each building by identifying inefficiencies, anomalies, overspend resources and propose behavioural actions,
- enabling fair competition and game mechanics in achieving low energy consumption between user communities as mean to educate as well as engage humans

How planned results can be measured (behavioral efficiency)

The goal is to reduce consumer's energy consumption by at least 10% using behavioral approach and game mechanics, even though much larger savings have been reported in relevant installations. The installed smart energy meters measure and push the energy consumption data to a scalable cloud aggregation system via a secure communication channel. Groups of consumers will be in charge of monitoring their building's energy performance through the use of the interactive social media web platform and mobile apps. Via a real-time intuitive interface, the building community will be taught the correlation between the actions they undertake and the energy consumption/CO_2 emissions of their building, providing in this way significant motivation for behavioral changes.

Social DR 2.0: social engagement and use of social energy networks for increase of DR/DSM engagement and perception for DSM motivation. Specific social KPIs for behavioural approach to Social DR 2.0 are:

- The fraction of customers engaged in social communities (Facebook %).
- Number of social DR transitions through social DR groups (Facebook %).
- The load of capacity each customer shifted through Social DR APIs (No).

- The number of customers used mobile API to engage in DR (%).
- The fraction of customers subscribed to all social DR 2.0 APIs (No).
- Comparison of DR engagement and efficiency among tradition DR and Social DR (%).

About the Authors

Co-founder, Chairman and CEO
PhD in Energy KDD @ NTUA,
studies at Dundee, Imperial, LSE, Cambridge CUED,
Ecole polytechnique

Vassilis Nikolopoulos, co-Founder and CEO is responsible for the innovation, strategy, and leadership of Intelen. Vassilis is conceptualist, entrepreneur, innovator and passionate with technology futurology and trend forecasting with more than 8 years of experience. He has strong background in mathematics, conceptual engineering with focus on Energy ICT, AMR/AMI, Smart Grids and vision to optimize human life in the next years. From 2005 to 2010, Vassilis worked on technical trend forecasting methodologies and innovation management procedures, focusing on the cleantech domain. He has many awards and global recognitions with his start-up, in top innovation and entrepreneurship contests (Red herring global, Kouros Entrepreneurship prize, SVASE Silicon Valley Launch, Siemens global smartgrid innovation award, OECD best eco-innovation model) and was voted as the best new entry researcher in Greece in 2007. He managed up to now, to raise over $380K in seed funding and over 1,2M Euros in EU grants. Vassilis holds a PhD in Energy KDD from National Technical University of Athens (NTUA), while he has studies at Dundee, Imperial, LSE and Ecole Polytechnique.

co-founder, CTO
MSc in Computer Science @ TUM,
Dipl. Chem. Engineering @ NTUA,
PMP,OCP

Konstantinos Staikos combined his technical foresight with Vassilis Nikolopoulos' vision to co-found Intelen in 2007. Konstantinos has more than 10 years of experience leading engineering teams in building complex enterprise software systems and is a widely respected technology leader in IT sector. He has a history of working on several EU Projects from a position of Technical Architect. More like a generalist rather than specialist, Konstantinos holds several IT (Oracle, Sun, SAP, ISTQB etc) and Project Management (PMI PMP& ACP) certifications. He has many awards and global recognitions with his start-up, in top innovation and entrepreneurship contests (Red herring global, Kouros Entrepreneurship prize, SVASE Silicon Valley Launch, Siemens global smartgrid innovation award, OECD best eco-innovation model). He managed up to now, to raise over $380K in seed funding and over 1,2M Euros in EU grants. Konstantinos holds a B.S in Chemical Engineering from National Technical University of Athens (NTUA) and a M.S in Software Engineering from Technical University in Munich (TUM)

Selected Publications

- Nikolopoulos, V; Mpardis, G; Giannoukos, I; Lykourentzou, I; Loumos, V (2011). Web-based Decision Support System Methodology for Smart Provision of Adaptive Digital Energy Services over Cloud Technologies, IET Software Journal, Issue Date: Oct. 2011 Volume: 5 Issue:5 On page(s): 454 - 465
- Pazalos K., Loukis E., Nikolopoulos, V., (2010). A structured methodology for assessing and improving e-services in digital cities, Telematics & Informatics Journal, Elsevier doi:10.1016/j.tele.2010.05.002
- Nikolopoulos, V, Loumos, V, A Web-based Information System for Optimal Energy Sources Mamagement through Ontologies and Hypercubic Clustering, Energy International conference, 2006
- Nikolopoulos, V, Loumos, V, Web-based energy information system for optimal bi-directional behavioural control of various energy customers using ADSL hypercubic clustering and internet services (emir system), PSM Conference 2007
- "A Web-based system for optimal Energy Sources Management, through Ontlogies and Semantic Clustering", Nikolopoulos, V, Vassili Loumos, presented at the Technical Chamber of Greece Research Conference, 2006

    - http://www.oecd.org/sti/innovationinsciencetechnologyandindustry/49521648.pdf
    - http://www.smartgridcontest.com/idea.php?id=153