POWERMATCHER
MATCHING ENERGY SUPPLY AND DEMAND TO EXPAND SMART ENERGY POTENTIAL

TNO innovation for life

Perhaps one of the most critical issues in the energy transition is matching sustainable energy supply and demand, and managing the influx of prosumer energy creation. With PowerMatcher, TNO has not only found the solution, but has proven its effectiveness and is ready to provide it on a wide scale. By offering PowerMatcher on an open-source platform, TNO is accelerating the energy transition and harnessing the power of the Smart Grid.

POWER MATCHER

ADDRESSING THE CHALLENGES

Since sustainable energy sources, like wind and solar energy, fluctuate in availability, effective means of utilising these resources when they are available is key to the energy transition. As renewable energy sources – both large- and small scale – increase, power grids face ever-increasing congestion. Consumers are purchasing more and more Smart Devices, and want them to work as effectively and efficiently as possible. Only through the use of a single, standardised, recognised system for managing interaction between Smart Devices and the grid can truly widespread adoption of sustainable energy resources be effectively utilised.

MAKING CONNECTIONS

Together with energy suppliers, DSOs, manufacturers, IT experts and municipalities, TNO developed and refined PowerMatcher technology. With minimal adjustment to existing infrastructure, PowerMatcher is a coordination mechanism that matches energy supply and demand, across a variety of sources and price points. PowerMatcher can also shift loads away from high peak demand moments, which prevents networks from overloading and uses available capacity in the smartest way possible. In short, PowerMatcher turns today's grid into tomorrow's Smart Grid. And since PowerMatcher is available on an open-source platform, any interested stakeholder can take advantage of this proven technology right now.

PowerMatcher
– Better integration of sustainable energy
– Higher market value for green electricity
– Relieves the power grid
– Ready for commercial use at any scale
– Open-source technology

MEET POWERMATCHER

PowerMatcher is a solution that combines IT, electrical engineering, economics and control. The design is based on multi-agent systems, which makes PowerMatcher highly scalable and able to ensure user privacy at all times. It offers reliable, efficient, balanced energy at all times of the day or night, and addresses all of the flexibility needs of Active Demand.

PowerMatcher allows more renewable energy to be integrated into the electricity system. By effectively matching supply and demand, it makes better use of available sources of energy. This significantly reduces the need for energy from other sources, such as fossil fuels.

Proof of PowerMatcher's capabilities became evident during a study of energy consumption among 3,000 households who utilised power from a large offshore wind turbine park. Using PowerMatcher, approximately 65-90% of the wind power, which would normally not be used without coordination, could be locally utilised. As a result, fossil fuel consumption among the households was reduced by 14-21%.

ENSURING SCALABILITY

As the use of Smart Devices increase, and the number of municipalities and households join the Smart Grid, scalability becomes a key component. That's why PowerMatcher was designed to coordinate and manage a large number of small- and medium-sized energy-demanding devices. PowerMatcher enables control over this ever-increasing load, and the distributed generators that create it – from rooftop solar panels to small wind turbines to massive wind parks.

PowerMatcher's distributed software system enables intelligent agents (devices and electric vehicles) to maintain responsibility for the local sub-tasks, and allows communication among and between them and the Smart Grid to maximise the success of the higher system goals. PowerMatcher provides a single standard for that communication, so that agents work together in a cohesive and effective way. Local software agents take care of local business, screening out potentially privacy-sensitive information before passing energy usage information to the grid. PowerMatcher coordinates a large number of smaller consuming (and producing) devices, without compromising the privacy and autonomy of the users.

To make PowerMatcher's scalable solution widely accessible, TNO made PowerMatcher available on an open-source platform as part of the Flexiblepower Alliance Network (FAN). FAN seeks to accelerate the energy transition by offering a single set of standards and software that accommodate the widest possible range of Smart Devices and vehicles. Equipment manufacturers and energy suppliers benefit from using an already-proven technological platform, and save precious time and money as compared to finding their own solutions. By using the standards set forth by FAN, devices and vehicles are assured to connect to the grid in the most effective way possible, opening the door for further innovation and integration of Smart Energy solutions. And through it all, PowerMatcher provides the coordination and control to balance loads and prevent congestion.

REAL-WORLD APPLICATION

TNO embarked on a series of projects to prove its value in the real world. By testing PowerMatcher's capabilities in a number of different settings, TNO has gathered sufficient data to ensure the scalability, reliability and flexibility of the system.

Together with KEMA, GasUnie, Essent, Humiq, Enexis and various universities, TNO developed PowerMatching City. It is a community in the Netherlands with homes that are completely connected to a Smart Grid. Appliances, heating and cooling, warm water and cars are all powered by the Smart Grid and managed by PowerMatcher. Now in its second phase of development, PowerMatcher City is the first real-world application of Smart Grid technology, powering 45 homes from top to bottom, from consumer to the energy market.

TNO's next challenge was 300 apartments in a single complex, all using Smart Grid-powered electric heat pumps.
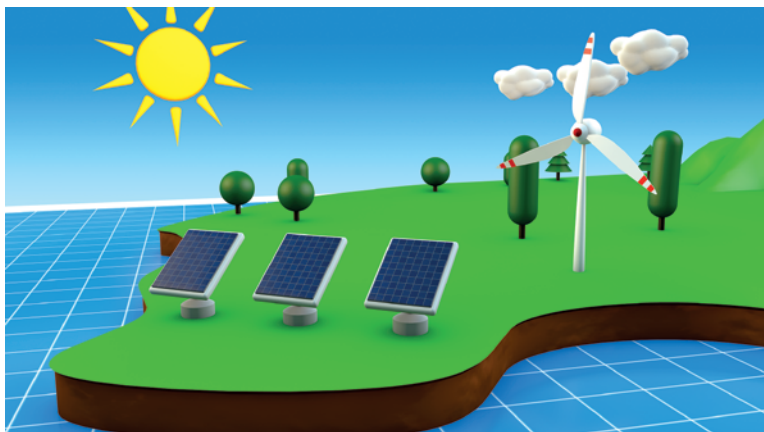
The Couperus project is the first experiment making use of the scalability capabilities of PowerMatcher. The retailer, Eneco, benefits by balancing the electricity flows and saving money on the imbalance market. The DSO, Stedin, is able to postpone or avoid huge investments in the expanding the electricity network.

PowerMatcher then scaled up again, in an international project involving 700 homes in Sweden. The EcoGrid project shows that with each scaling up of agents and participants, PowerMatcher still performs to expectations. The EcoGrid EU Consortium represents strong global industry experiences, and is therefore an important indication of the potential of PowerMatcher.

In the quest for even wider-scale application and adoption of PowerMatcher standards, TNO is now preparing for new projects that take the platform to new levels. From 700 homes in Sweden, our next step would be a market introduction that includes 10,000 to 100,000 devices, thereby providing further proof of PowerMatcher's ability to match supply and demand, even in these large-scale environments.

With each expansion and advancement in PowerMatcher's use, TNO gets one step closer to their ultimate objective: the Smart Energy Cities of the future, in which connecting to the Smart Grid is not only possible, but common. Offering PowerMatcher on the open-source FAN platform brings TNO even closer to this objective.

RESULTS IN PRACTICE

Effectively matching supply and demand can truly capture the potential of the fluctuating supply of renewable energy. In fact, it can even increase its value. The low day-ahead predictability of wind energy, for example, results in additional costs assigned through the electricity wholesale markets – so-called 'imbalance costs'.

In two of the field tests performed with PowerMatcher, a wind farm was connected to a flexible cluster in order to compensate for deviations from the predicted wind power. This reduced the imbalance caused by the wind farm by 40 to 60%. Energy suppliers take notice of significant improvements like that.

PowerMatcher has also proven to prevent overload in electricity networks. By managing heating systems (micro-CHP and heat pumps) and electric car charging in a smart and efficient way, PowerMatcher could typically reduce daily peak loading by 30 to 35%. In one case, PowerMatcher reduced network capacity to a level that was three times lower. That kind of reduction can eliminate the need for network operators to engage in expensive network reinforcement. In addition, new networks do not need to be designed in a complicated or over-dimensioned way. These real-world results are further proof of PowerMatcher's ability to serve the needs of the energy transition across the entire value chain.
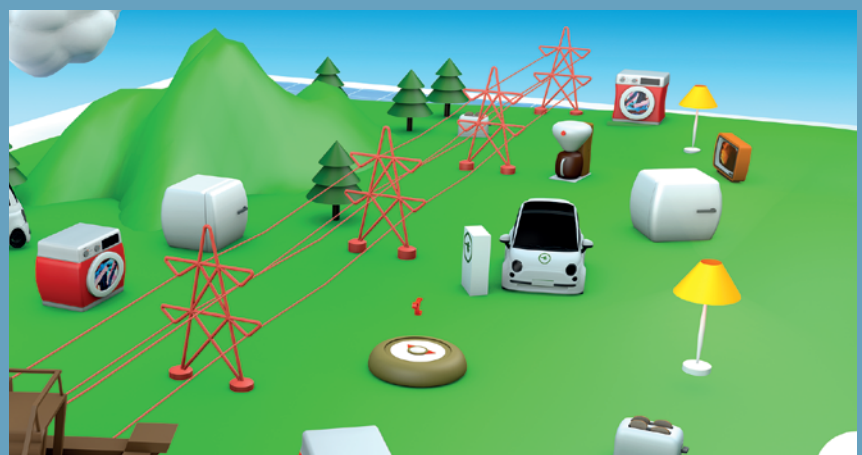
POWER TO THE PEOPLE

Active Demand is changing the energy landscape, as consumers gain more influence on the grid. As more individuals become producers of electricity (prosumers), the impact on the grid becomes more important to control.

With every Smart Device in use, consumers have more flexibility in the choices they make to achieve their desired outcomes. Each Smart Device can enable energy flexibility. Consumers can monitor, adjust, and schedule their energy usage to fit their own specific needs. Whether the objective is ultimate cost-savings, maximum green energy use or total convenience, users connected to the grid have choices about their energy consumption, and can see the real-world implications of those choices reflected in their energy bills and footprint.

PowerMatcher provides the key to social innovation by offering manufacturers a proven set of standards for device creation. These standards allow for flexibility and choice in energy consumption, thereby further managing the supply, and the demand, on the grid.

PowerMatcher's support of the energy transition can even extend beyond individual households, directly to municipalities that have ambitious Smart Energy objectives. To support the energy transitions, governments and regulators will need to consider changes to current legislation. Adaptions to the regulatory system and the adoption of flexible tariffs will play an important role. PowerMatcher's potential to provide balance and control in the face of this flexibility will be a crucial component.

FUTURE FOCUS

Although PowerMatcher has already enjoyed tremendous success in PowerMatching City, Couperus and EcoGrid, TNO knows that in order to accelerate the energy transition, there is still much more to be done. This begins with continuing the research and development already underway. Due to PowerMatcher's success on smaller scale projects, the next step will be larger pilots and scaled-up usage of the technology. TNO is ready to partner with municipalities, large companies or consortia that are engaging in large-scale Smart Energy initiatives. That includes international collaborations and projects that connect tens of thousands of devices.

Software companies, manufacturers, equipment suppliers and (foreign) municipalities interested in taking another step towards the Smart Energy Cities of the future need only to contact TNO to find out how PowerMatcher can provide one of the keys. Offering this effective way to balance energy supply and demand, on an open-source platform, is the fastest and most effective way to stimulate the transition and make great strides in the search for effective, efficient energy solutions.

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MORE INFORMATION

For more information on PowerMatcher, its running projects, or the open-source FAN initiative, please contact Joost Laarakkers or visit one of the sites below.

– **TNO**: www.tno.nl/powermatcher
– **PowerMatcher**: www.powermatcher.net
– **Flexiblepower** Aliiance Network (FAN): www.flexiblepower.org
– **PowerMatching City**: www.powermatchingcity.nl
– **Couperus**: www.rvo.nl/sites/default/files/ Couperus%20smart%20grid_0.pdf
– **EcoGrid**: www.eu-ecogrid.net

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