# SIEMENS
*Ingenuity for life*

# Newly developed Active Network Management functionality

**in the context of the SINTEG/enera funding program**

## Introduction

The expansion of renewable energies has a big influence on the operation of the power grids. Additional measures are essential to safeguard a stable grid operation. Until now the means of choice to reduce power generation peaks in the distribution network was mainly the feed in-management. Distribution system operators (DSO) ask whether the Demand Response approaches commonly used on the transmission network level could be applied to the distribution networks. Their specific questions were, as follows:

- How good are the congestion forecasts in the distribution network?
- Is sufficient flexibility available to mitigate the peaks of the power generation and to meet even higher energy demand in the distribution network?
- Under which circumstances is Demand Response an alternative to cutting generation peaks on the distribution level?
- How might the regional markets be constructed to make an efficient Demand Response possible in the distribution network?
- Can the expected savings on compensation payments be achieved?

While searching for answers to these questions, Siemens took part to a grant-aided project and drove forward here in the enera Use Cases a new Active Network Management (ANM) forecast functionality.

In the integration of renewable energy into smart grids Siemens was able to give a proof of its expertise in two of five core research areas sponsored by the Federal Ministry of Economy and Energy (BMWi) and defined as "Smart Energy Showcases".

Before moving on to report how the new ANM functionality responds to the actual challenges in distribution networks, we provide a short presentation of the complete Siemens' contributions to the research program.

### Siemens Digital Grid participated in two projects in the funding program for the energy supply of the future

The Federal Government supports the development of renewable energies with numerous projects and laws focused to reduce the use of fossil or atomic energy. In the "Smart Energy Showcases – Digital Agenda for the Energy Transition" program (SINTEG) of the BMWi transmissible model solutions for a safe, economic and ecologically compatible energy supply are developed and tested. This is done within model regions in which renewable energies can provide temporarily 100% of the energy demand.

The five Smart Energy Showcases ran for four years from 2017 until the end of 2020.

- C/sells: Extensive showcase in the southern German solar arc
- DESIGNETZ: Energy transition construction kit
- enera: Digitization of energy supply
- NEW 4.0 – North German energy transition: From power to energy transition
- WindNODE: The showcase for smart energy from Germany's northeast

Siemens participated as a research partner in two Smart Energy Showcases: WindNODE and enera. These are the respective contributions:

| WindNODE:<br>2 Work Packages | Enera:<br>2 Use Cases |
|---|---|
| • Judging the entire system efficiency<br><br>• Flexible production – industrial load management | • Active Network Management (ANM)<br><br>• Smart Grid Logical Data Model (SG-LDM) |

The goal of the Siemens' work packages in the WindNODE project was to examine, how an economically optimized combination of batteries, flexible loads and flexible generation as well as suitable market models can be determined in order to be able to measure the competitiveness and efficiency of the smart energy system. Siemens investigated and forecasted here the current demand of thermal, mechanical and electro-chemical production processes as well as the production processes in four industrial plants in Berlin-Siemensstadt to create the prerequisite for a load shifting in times of low electricity prices.

The research goals in the enera Use Case SG-LDM are built of the integration of data and applications from the IT/OT world. Control functions of the distribution network automation were related to market views. New business fields based on Smart Data technologies and Smart Services were successful developed.

In the enera ANM Use Case the new Active Network Management forecast functionality was realized on the basis of the Spectrum Power™ platform. The necessary interfaces were tested and integrated in a one-year-field-proof in the enera model region. The results were regularly presented and discussed with the enera associated partners.

An in-depth look at the new opportunities opened for DSOs with the new Spectrum Power™ ANM functionality follows.

## A traffic light providing awareness of the network state and decision support for grid operators

The ANM consists of several applications developed with the aim of determining the present and forecasted electrical network state as well as generating necessary network optimization suggestions.

The focus of the new Spectrum Power™ ANM functionality is the use of flexible energy and optimized feed-in management for a smart mitigation of congestions in distribution networks. So, the local and regional power supply is supported both by optimization of generation-schedule proposals and by the trade of flexibility.

As shown in the traffic light logic in Figure 1, and as proposed by BDEW (German Association of Energy and Water Industries), the ANM with its new forecast functionality delivers a classification of the current and of the future network state. The yellow and red lights allow the distribution system operator to recognize the network state and to
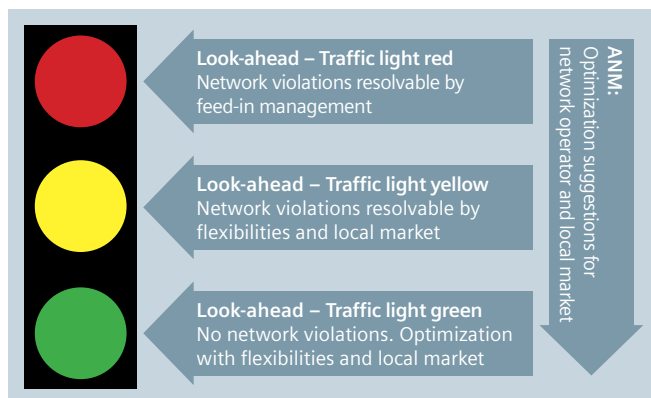


**Figure 1:**
**The meaning of the lights in ANM look-ahead mode according to the BDEW concept**

set the suggested countermeasures.
This image also defines what transactions are allowed on the spot market given the expected network state. The goal is to prevent that market transactions drive network congestions and to establish the regional market as a flexibility provider in times of problematic network states.

The main applications of the Siemens Active Network Management with the new look-ahead functionality are:

- **Distribution System State Estimator (DSSE):**
  An innovative state estimation for distribution networks which can handle the missing measurement redundancy in the distribution network in balanced and unbalanced configurations.

- **Voltage Var Control (VVC):**
  An application which can calculate optimal use of heterogeneous equipment for the control in the network, which is based on results of the state estimation under consideration of different constraints. The equipment ranges from controls commonly used by voltage and reactive power optimization to controls required for flexible power optimization.

- **Data Interfaces:**
  Responsible for processing of external input data including measurements, schedules and forecasts and forwarding of the results of the ANM to third parties.

In the look-ahead mode, as shown in Figure 2, the state estimation and optimization can be calculated not only for single time instances in the future. Even the calculation of complete time series with configured length and resolution can be carried out. The duration of the violations and therefore the duration of the necessary usage of the flexible energy by the market can be determined from the obtained results. The state estimation and optimization are
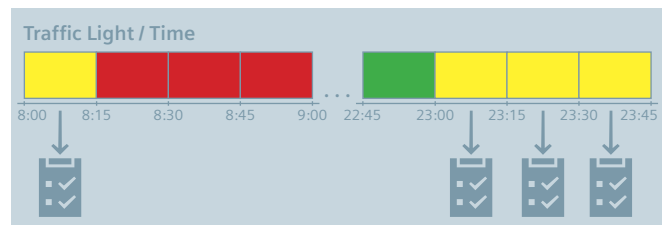


**Figure 2:**
**ANM look-ahead mode**

executed by default every 15 minutes for up to 96-time instances.

From the results for one time series, a flexibility request for the regional market is being generated. On demand, the request is created for each time instance of the time series.

How the Siemens Active Network Management (ANM) with the new functionality - implementing the yellow light in look-ahead mode - runs, is shown in Figure 3.
External data like schedules, forecasts, switch positions and network data are fed into the ANM. The ANM then calculates the network state and determines the traffic light. The optimization utilizes only the equipment allowed for the corresponding traffic light. In case of the yellow light, flexible load and generation can be used within optimization. The required flexibility is estimated, and a flexibility request is being forwarded to the market interface.
The activities on the market are considered in the schedules of the flexible plants and are transmitted to the ANM over a corresponding interface. The outlined circle closes, then a new forecast and the accompanying schedules start a new optimization iteration.
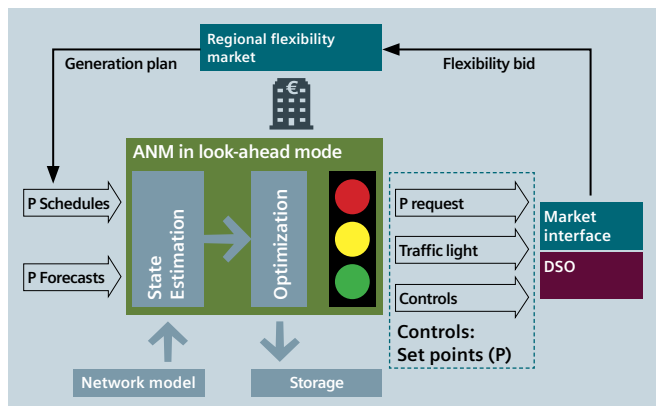
**Figure 3:**
**Active Network Management in look-ahead mode**

The presentation of the calculation results in an user inter-face provides more transparency about the future network states, the number of possible congestions and the point in time of their occurrence. It also demonstrates the resolvabi-lity of the network problems with the available flexibility to the distribution system operator and allows to estimate how much flexibility must be available in a volatile network to resolve all forecasted violations.

As a conclusion, with the new Spectrum Power™ ANM functionality distribution network congestion due to renew-able generation can be reliably forecasted and resolved. The required flexibility can be automatically forwarded to the regional market interface.
The new ANM functionality is now available on the Spectrum Power™ platform for DSOs.

For more information about ANM, please visit our webpage: https://new.siemens.com/global/de/produkte/energie/ener-gieautomatisierung-und-smart-grid/spectrum-power-man-agement-systems/spectrum-power-anm.html

### Note to the funding projects enera and WindNode
Siemens thanks the associated partners involved in the projects enera and WindNODE, and particularly the partners in the work packages of "Smart Grid operator" and "Smart data and service Platform".



### Further information: SINTEG and enera
enera – The next big steps of the energy transition (only in German)
https://projekt-enera.de/

New business models in the context of the digital energy system (only in German)
http://appstore.projekt-enera.de/

SINTEG – Smart Energy Showcases
https://www.sinteg.de/en/

SINTEG Final Conference (only in German)
https://www.sinteg.de/termine/aktuelle-termine/detailseite/sinteg-abschlusskonferenz/

### Further information: WindNODE
Showcasing smart energy systems from north-eastern Germany
https://www.windnode.de/en/

WindNODE Future Space Energy
https://new.siemens.com/global/en/company/fairs-events/futurespaceenergy.html

Complete yearly PDF-report can be downloaded
https://www.windnode.de/ergebnisse/windnode-jahrbuch/

**Main advantages for DSOs:**

- Optimization of the distribution network containing volatile energy sources

- Reliable resolution of violations in the network

- Avoidance of costly network reconstruction

- Increased revenue due to the trade with flexibilities

- Visualization of the network state in accordance with the BDEW traffic light concept