Introduction to VDE-PB-014:2015

A test specification supporting fuel savings simulations for hybrid-power systems

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Figures and facts about VDE

- VDE – Verband der Elektrotechnik Elektronik Informationstechnik e.V.
  English: VDE – Association for Electrical, Electronic & Information Technologies
- Founded in 1893 on the initiative of Werner von Siemens and others
- 1906 one of the few founders of IEC Standardization Organization
- Headquarters in Frankfurt/Main,
  political representation in Berlin and Brussels
- Offices in Europe, Africa, Asia and North America
- 36.000 personal members, 8.000 students
  1.300 company memberships
- 60.000 participants at VDE events every year
- Support of young engineers within 60 university groups
- 1.100 employees, around 150 Mio. Euro turnover

The VDE Institute

Creating synergies between testing & certification, and R&D services

One test – multiple certifications – worldwide market access

Introduction to the test specification

Motivation behind the new test specification

- Integration of PV systems is often a viable solution to cost-effective distributed generation
- More private sector financing is needed to increase the penetration of PV-hybrid systems
- However, private sector financing calls for proper system design and business models that are based on reliable data
  - Specifically – will the integration of PV into an existing generator system result in sufficient fuel savings to justify the investment?

Current market conditions

- Field experience shows that simulations often rely on broad assumptions and scarce measurements
  - This could lead to improperly designed PV systems that do not meet demand, or are oversized and thus financially non-viable

- Non-transparent input data, undeclared assumptions, lack of sensitivity analyses for assumptions made are all obstacles for PV-hybrid projects

- The above obstacles make it difficult to have a reliable basis for fuel savings calculations, and thus financing remains too expensive

The standardization project team

- Three organizations from different parts of the energy ecosystem:
  - GIZ – Project Development Program supports enterprises in market positioning and project development in developing countries
  - OneShore – project developer with experience in developing countries
  - VDE Institute – testing, certification & standards development

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

VDE INSTITUT

oneSHORE

The solution: a 4-part test specification for fuel savings simulation

Part 1
Load measurements and extrapolation

+

Part 2
Simulation input parameters: Generation
Technology: PV-combustion hybrid

Part 2
Future technologies:
e.g. Wind-combustion

+

OPTIONAL

Part 3
Simulation input parameters: Storage
Technology: Chemical batteries

Part 3
Future technologies:
e.g. Flywheel

Part 4
Simulation model

- Does not approve the optimal design of a PV-diesel hybrid
- Sets minimum requirements for load measurement, input parameters and data, and simulation model
- Ensures that fuel savings are calculated following high standards

Part 1: Load measurements and extrapolation

- Procedure for measurement of actual load
  - Time steps/resolution for measurements
  - Length of load measurements
  - Power quality (frequency, power factor, harmonics)

- Methodology for data extrapolation if actual information is less than 1 year
  - Taking into account seasonality of demand, e.g. for use-cases such as tourism, utility, farming, hospitals

→ This does not apply to greenfield projects!

Output 1: realistic annual load curve

Part 2: Simulation input parameters: Generation (1)

- Compulsory generation-sided simulation input parameters - focused on PV-combustion hybrid case
  - Future editions to cover other technologies like wind-combustion hybrids

Input parameters:

- Combustion generator
  - Parameters – rated real power, derating factors, fuel efficiency
  - Operation – load sharing, schedule, spinning/operational reserve
- PV plant - performance ratio, degradation, potential losses
- Economic/financial - CAPEX & OPEX PV plant, WACC, diesel price & development
- Project details – ambient temperature, altitude, environment description

Part 2: Simulation input parameters: Generation (2)

Input data

- Solar irradiation
  - Actual global horizontal solar irradiation in W/m2, or
  - Synthetic time series generation using specified databases

- Ambient air temperature

- Wind speed

Output 2: generator parameters for simulation input

Optional Part 3: Simulation input parameters: Storage

Input parameters

- Batteries – type, nominal capacity, efficiency, depth of discharge, lifetime curve
- Battery converter – EURO efficiency, assumed lifetime, charge control
- System efficiency – efficiency outside temperature curve, efficiency-lifetime curve
- System operation – diesel-off mode, ramp rate control, frequency control
- Economic/financial – CAPEX battery replacement, OPEX battery system

Output 3: storage parameters for simulation input

Part 4: Simulation model (1)

System description

- Single-line diagram with all generation and storage facilities in Parts 2 and 3
- Battery application mode (load following vs. cycle charging)

Simulation input parameters and input data – simulation must be able to use input parameters and data specified from the previous parts

- Part 1: Load measurements and extrapolation
- Part 2: Generator simulation inputs
- Part 3: Storage simulation inputs
- Other inputs – simulation period, time steps, genset operating mode

Part 4: Simulation model (2)

Requirements for simulation process

- Simulate load for every time step over the whole simulation period based on Part 1 parameters and data
- Simulate renewable power generation
- Process respective fuel efficiencies
- Calculate optimal genset operation configuration
- Process price development of diesel/HFO/gas for simulated operation time
- Compare non-renewable base scenario with projected renewables scenario to calculate fuel savings through RE integration
- Battery system operation requirements
- Simulation of battery charging depending on application mode
- Stability criteria

Part 4: Simulation model (3)

Simulation output parameters

- Annual renewable power production
- Annual genset runtime
- Annual fuel consumption without renewables
- Annual fuel consumption with renewables
- Annual fuel savings
- Battery lifetime and depth of discharge

Simulation output data

- Actual loading parameter of generator for each genset
- Actual spinning reserve vs. required spinning reserve
- Actual vs. maximum depth of discharge

Part 4: Simulation model (4)

Financial simulation output parameters

- Total CAPEX, annual & monthly OPEX for hybrid system
- Annual and monthly cash savings
- Payback period, project IRR & NPV, equity IRR & NPV, reduced O&M costs

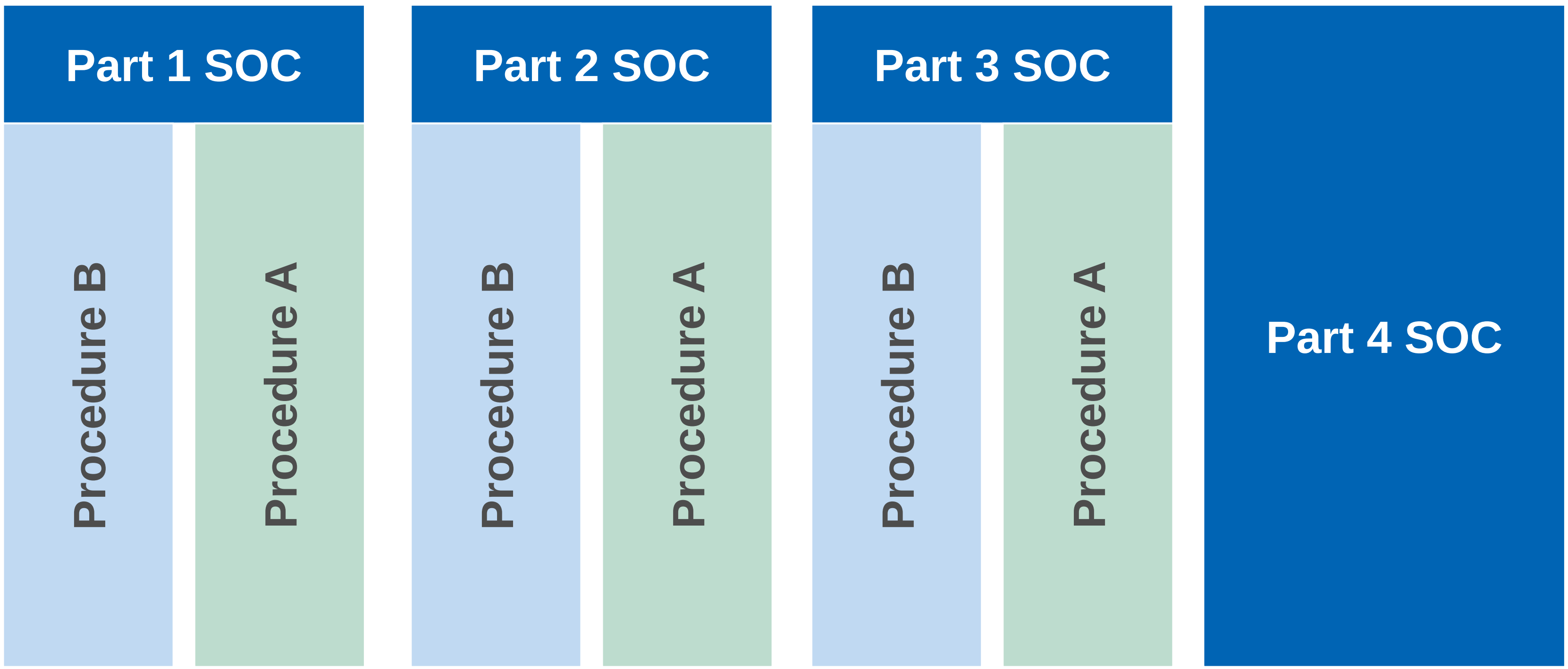
Requirements for presentation of results

- Technical overview – single-line diagram, generator capacities, datasheets
- Assumptions – simulation period, costs, diesel expenses, loading parameters
- Graphical results comparing RE production with load curve
- Non-graphical results – equipment lifetimes, fuel savings, cash savings IRR, NPV
- Name of simulation tool and tool developer

Output 4: specification for simulation software

Certification process

Two possibilities for certification



- A statement of conformity (SOC) is issued for each of the Parts 1 through 4
- Parts 1 through 3 can be certified according to Procedure B (basic requirements) or Procedure A (more stringent requirements)

Certification process

Project developers approach VDE Institute to
get the standard VDE-PB-014:2015

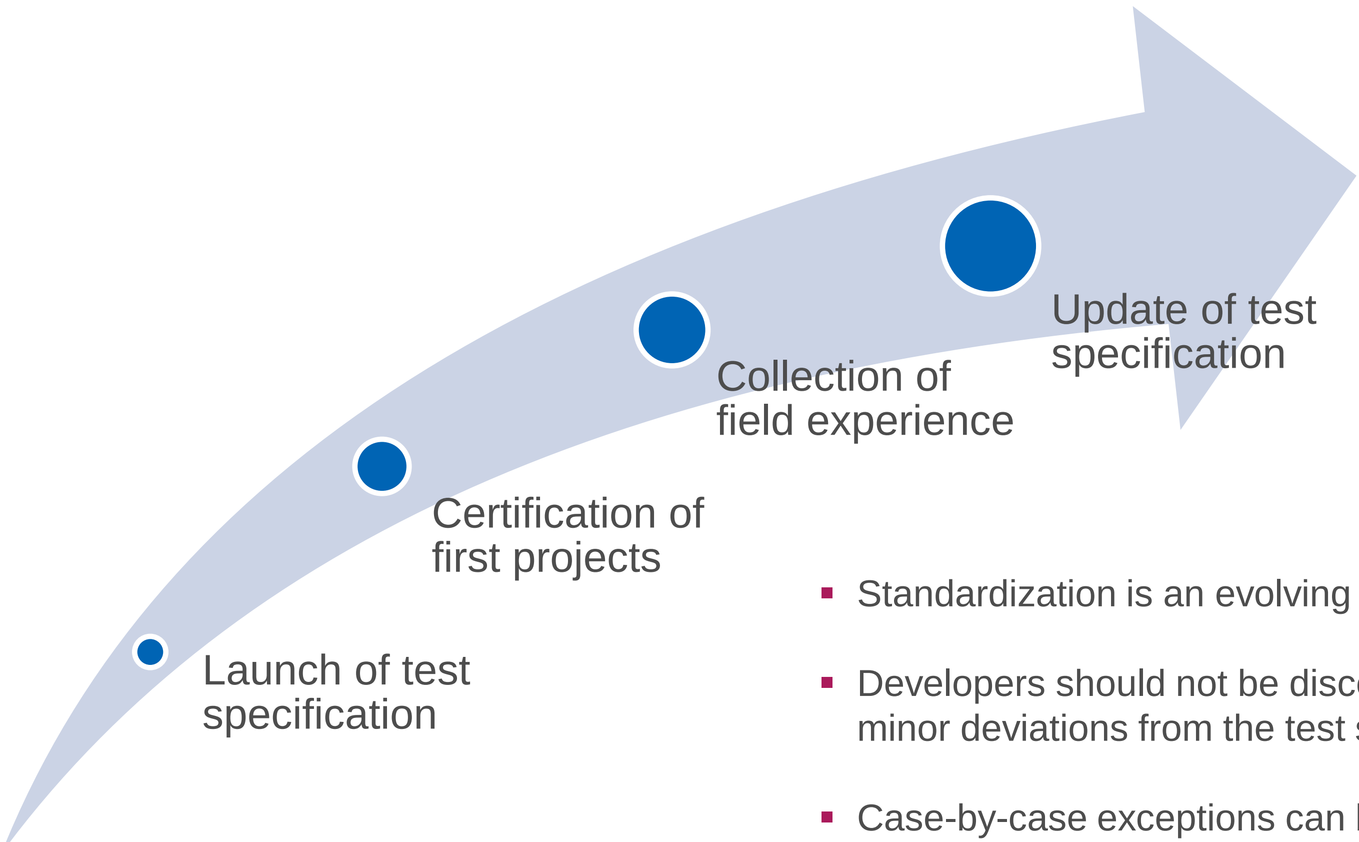
Apply for certification
(specify which Parts 1-4 are being applied for)

Submit project data

Approx. 2-4 weeks to evaluate data

Issuance of applicable SOCs
(which state if Procedure B or A was fulfilled)

Moving forward



Striving towards a well-adapted standard for the market

- Standardization is an evolving process
- Developers should not be discouraged if they have minor deviations from the test specification
- Case-by-case exceptions can be made, provided that deviations do not negatively impact the project

Summary - objectives

- Certification of fuel-saving simulations for PV-hybrid systems to support the business case
  - Build up trust in the project through objective quality criteria
  - Development of a professional market with easily comparable projects
  - Independently, specifications for reliable load measurements (Part 1) can be applied even for non-hybrid projects

- Test specification supports well-defined input data, transparent assumptions, and holistic simulation models
  - Reduced uncertainty and risk
  - Reduced financing costs for the project

Summary - benefits

Client/IPP	▪ Reliable and transparent information for PV-hybrid system selection process
Project developer	▪ Basis for establishing trust and building confidence amongst clients and financiers
Investor/ financier	▪ Quantitative reduction of risk allows for lower financing cost ▪ Enables greater participation in the PV-hybrid market thanks to more affordable financing products

We are pleased to be your partner!