How Energy Distribution Will Change
An ICT Perspective

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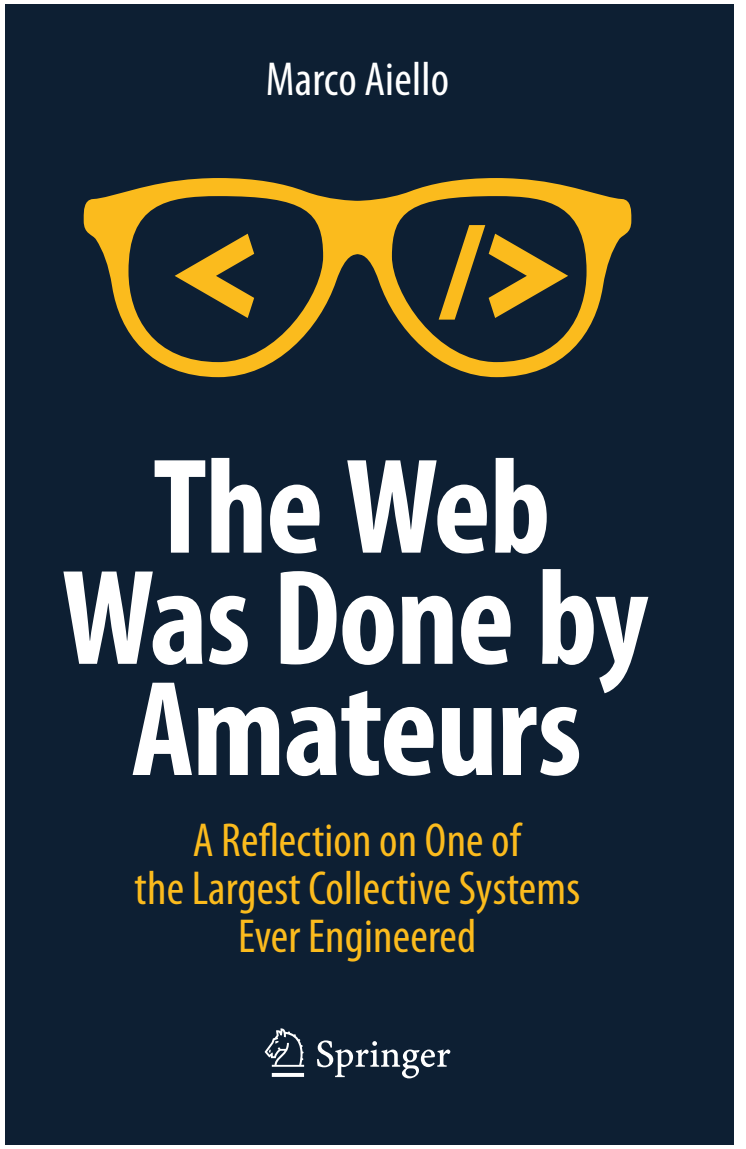
An update since last year

Featured as the August 2019 CACM Viewpoint article

Covered in a future issue of IEEE History of Computing

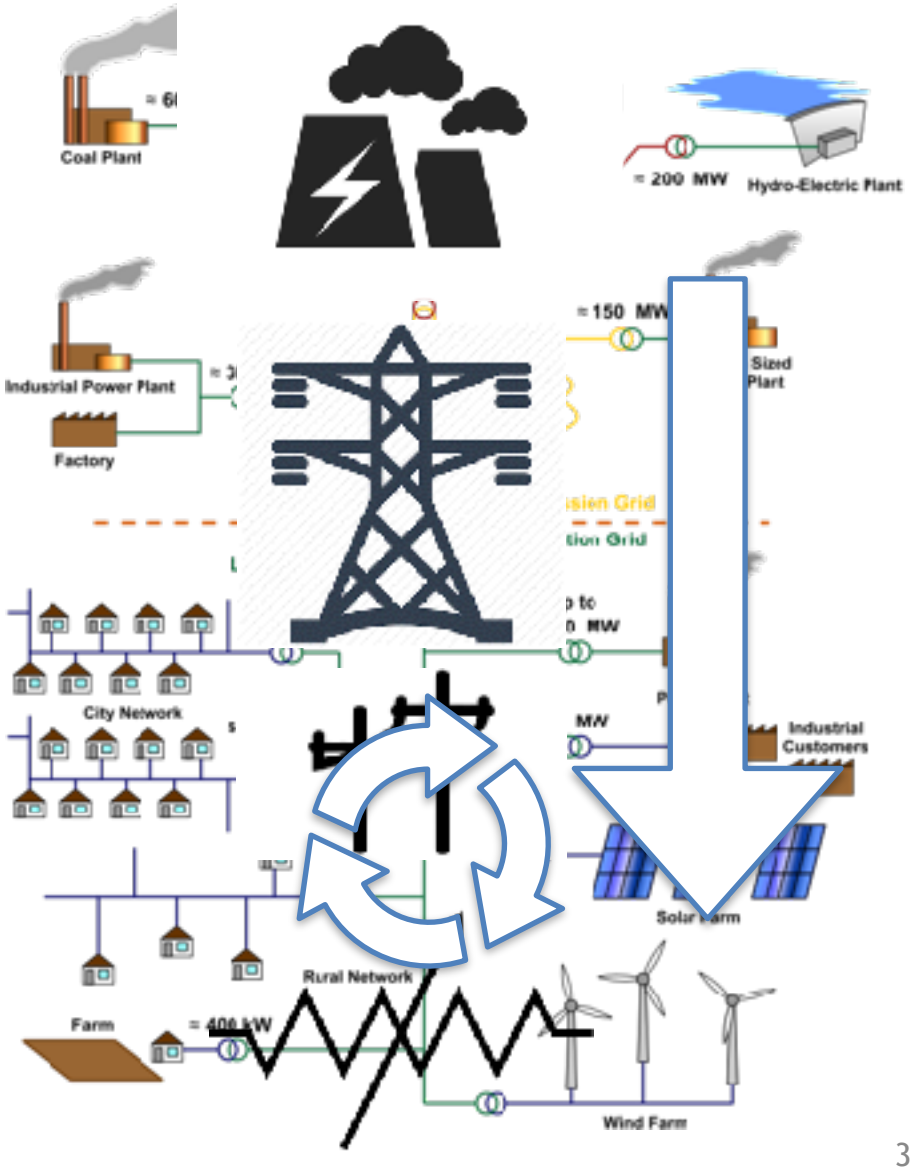
Best amazon.com ranking: 60th in Computing History



The Transition, Globally

"every home, every factory and every transportation line will obtain its energy from one common source, for the simple reason that that will be the cheapest way to produce and distribute it"

Samuel Insull
(1859–1938)



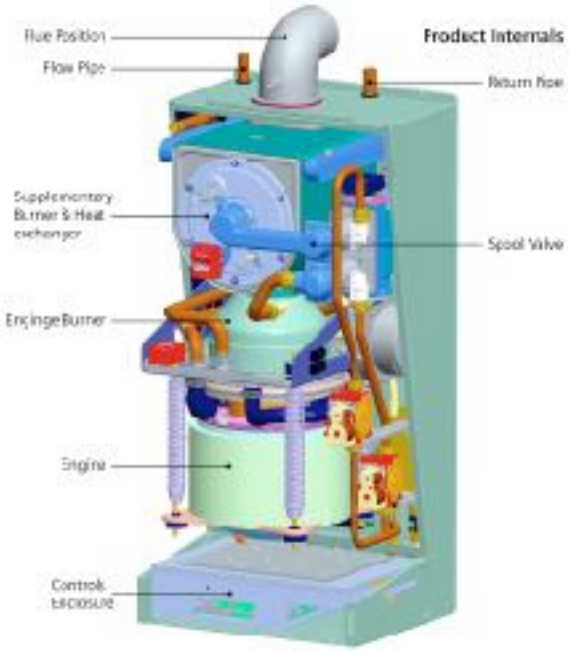
The Transition, Locally

PV and wind

Home automation

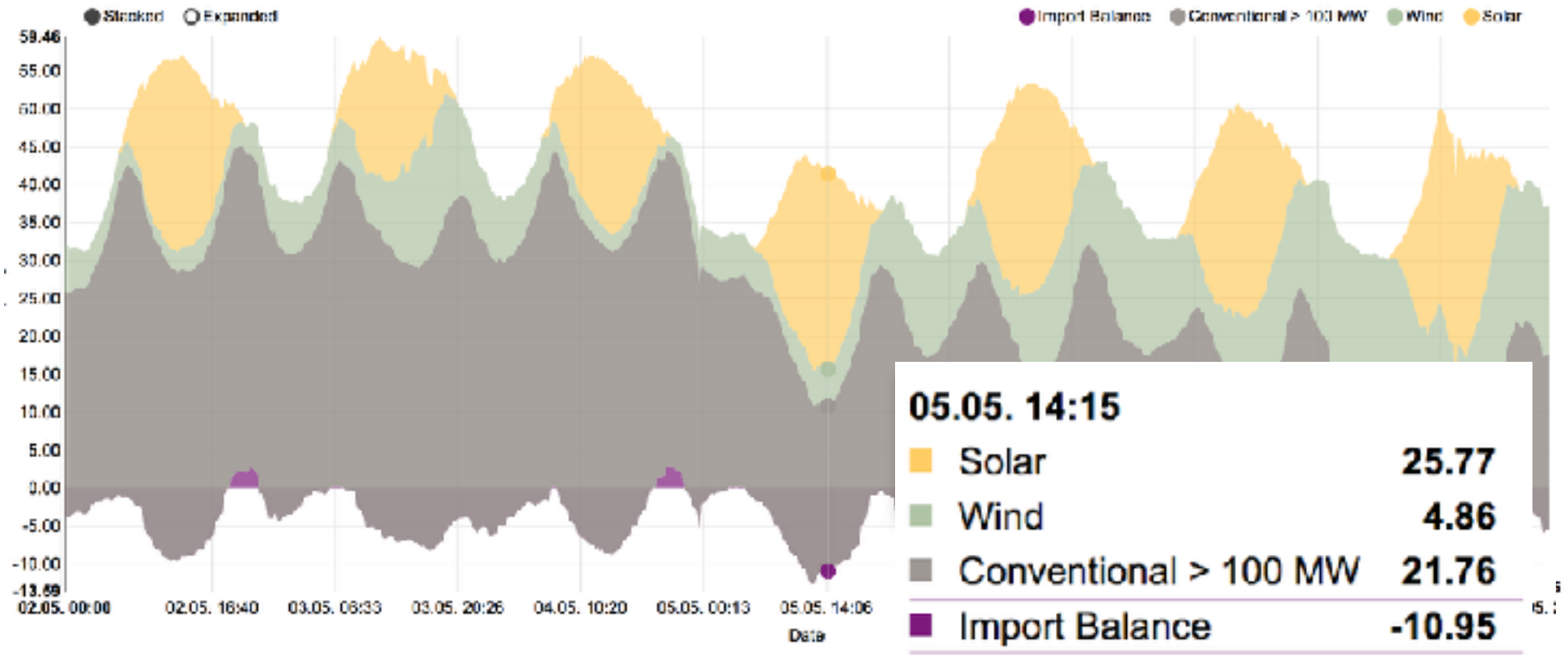
Digital, Smart Meters

Small-scale storage



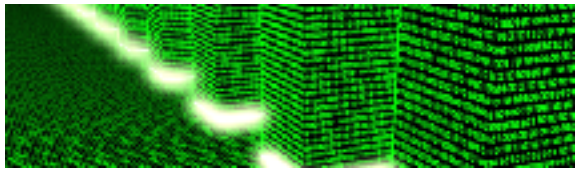
µCHP

The Problem, Globally



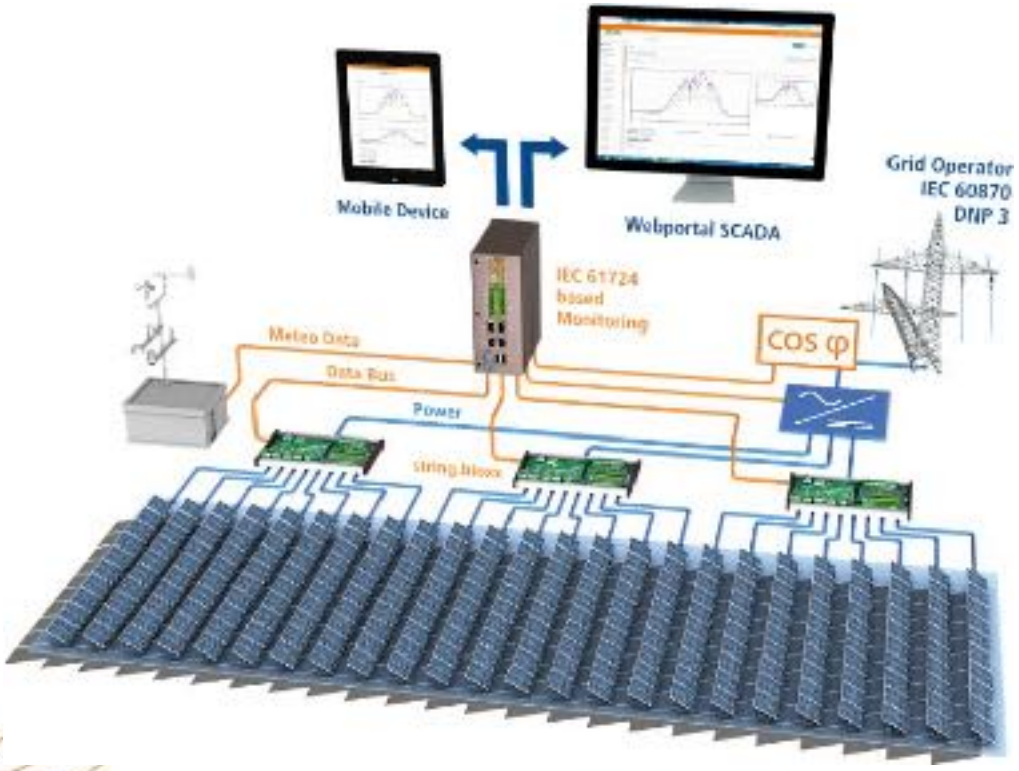
Source: ISE Fraunhofer

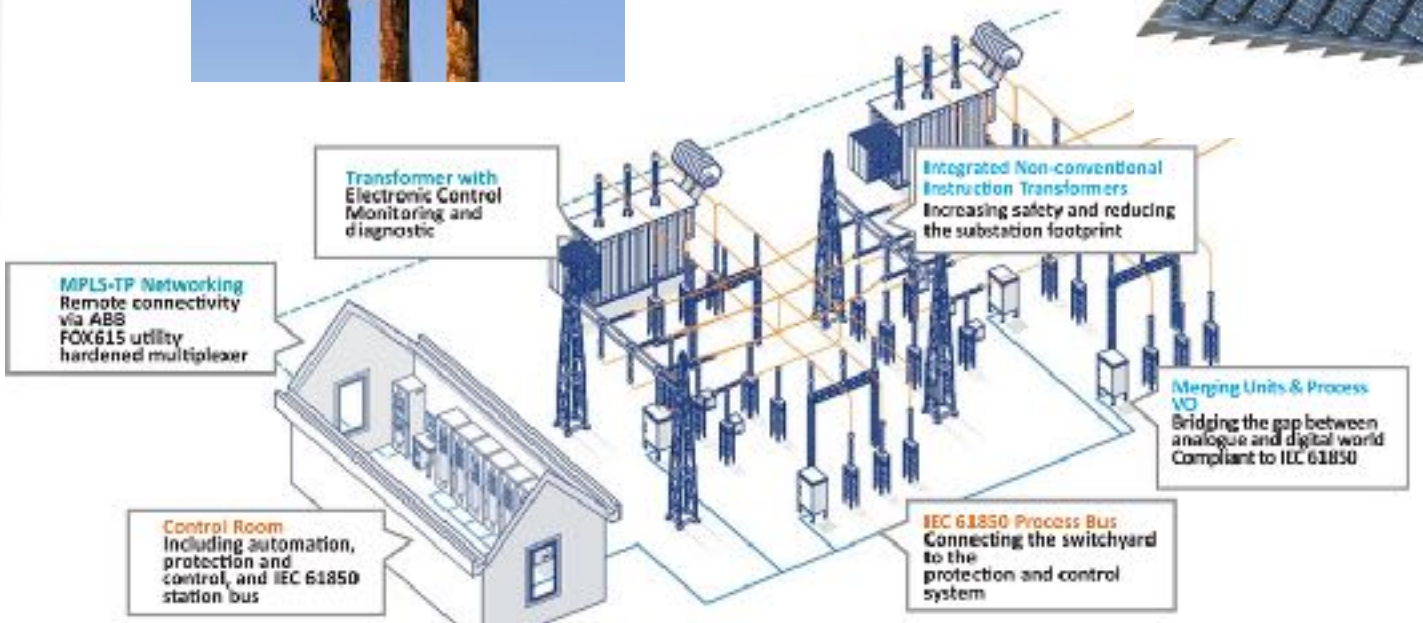
A New Wave of Digitalization



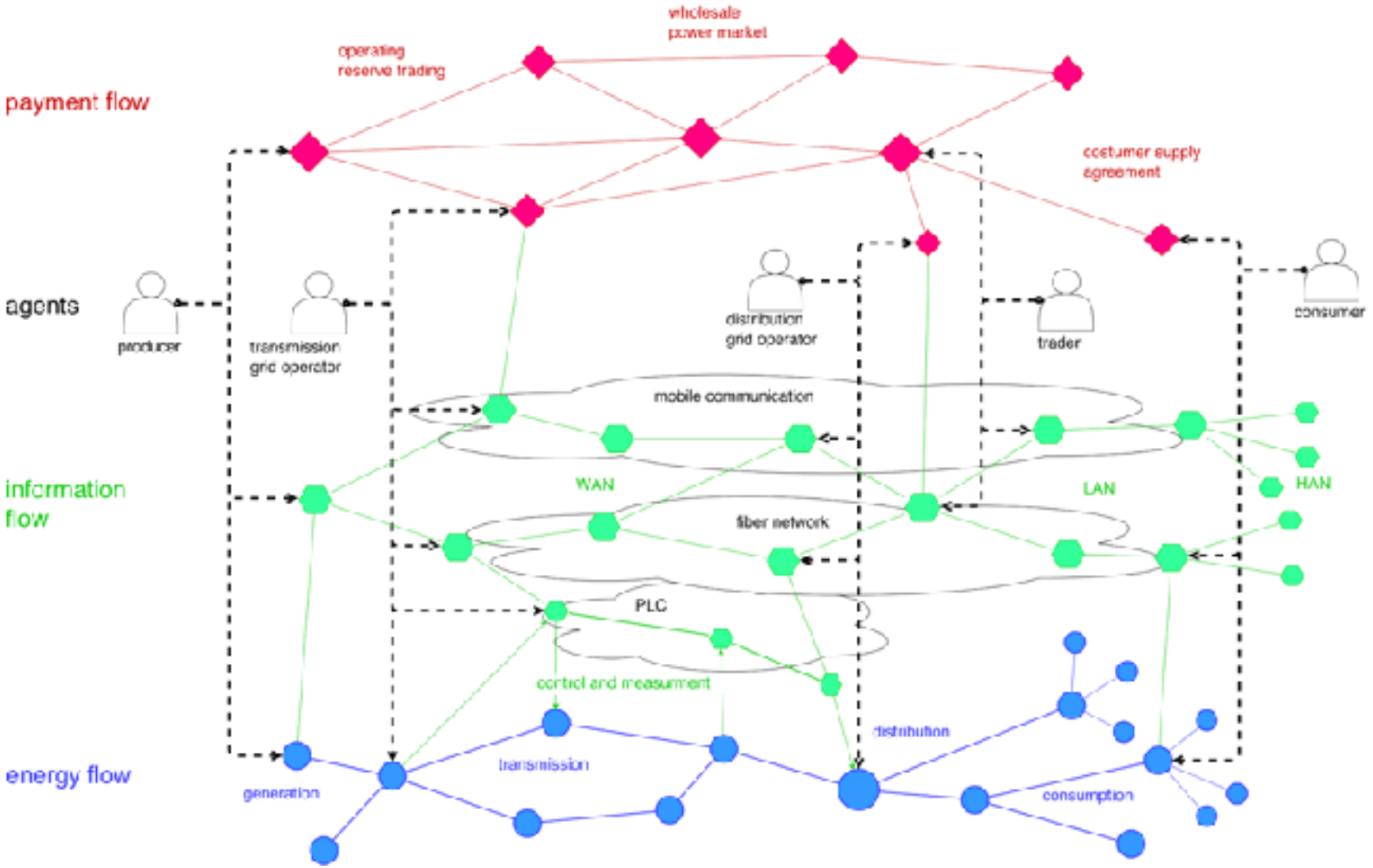
- Moving from estimates to accurate digital measures
- Modelling and simulating the whole complex system
- Real-time infrastructure monitoring and control
- From passive to active loads (smart homes, buildings, etc.)
- Abundance of data to learn and improve on

Digital metering and real-time monitoring

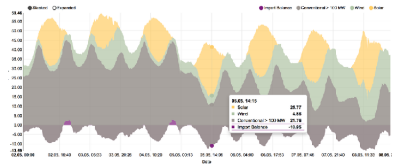


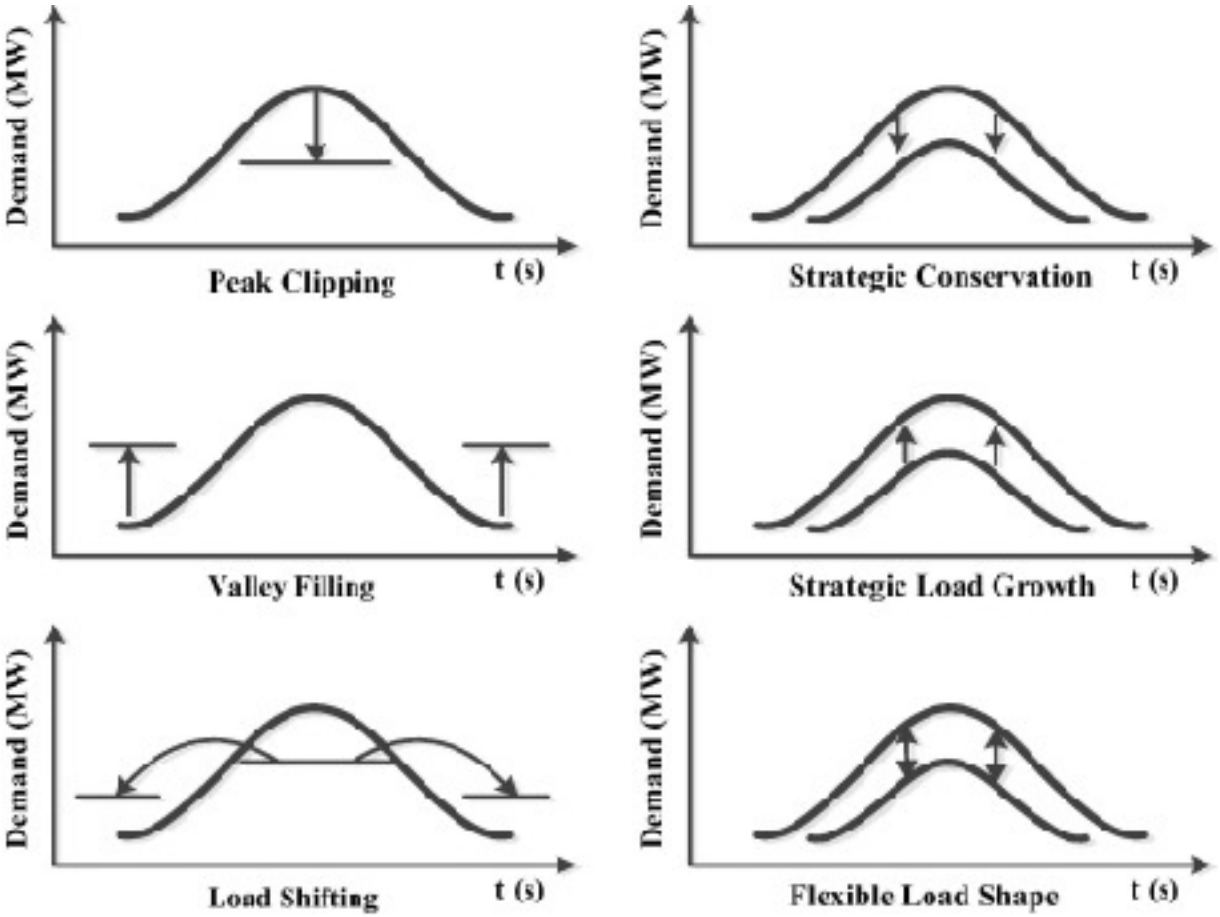


Complex Systems Modelling



Demand side management





Big Data Estimates

- [EDF] with 35 millions smart meters and a sampling at 10 minutes **120 terabytes/year**
- **[**IBM] white paper on Big Data and smart grids, 15 minutes sampling period, 3.000 fold increase of data
- Netherlands: up to 8.5 petabytes/year, [Aiello&Pagani, 2014]

- Companies with added value is largely based on energy data

OPOWER

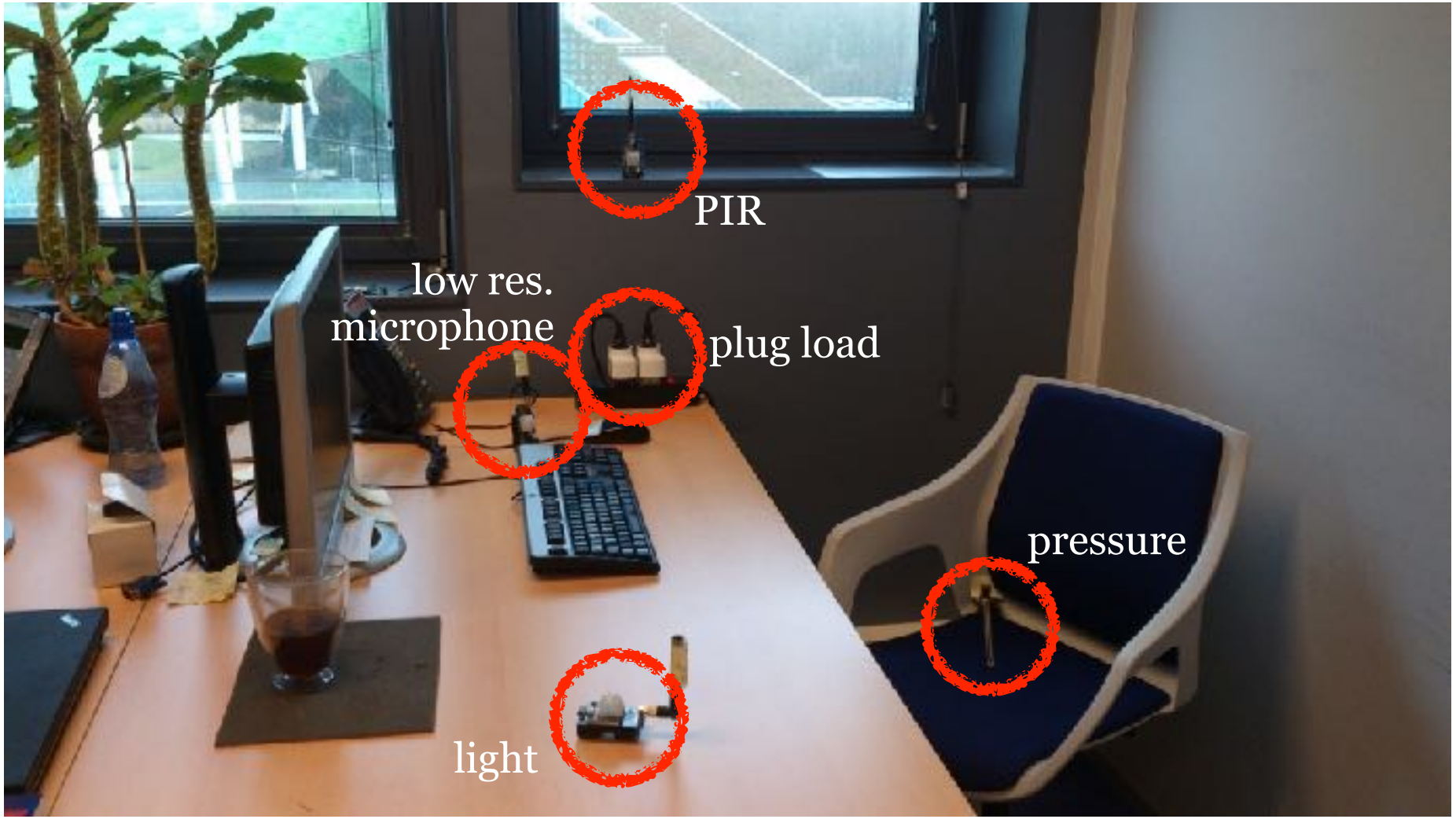
AutoGrid

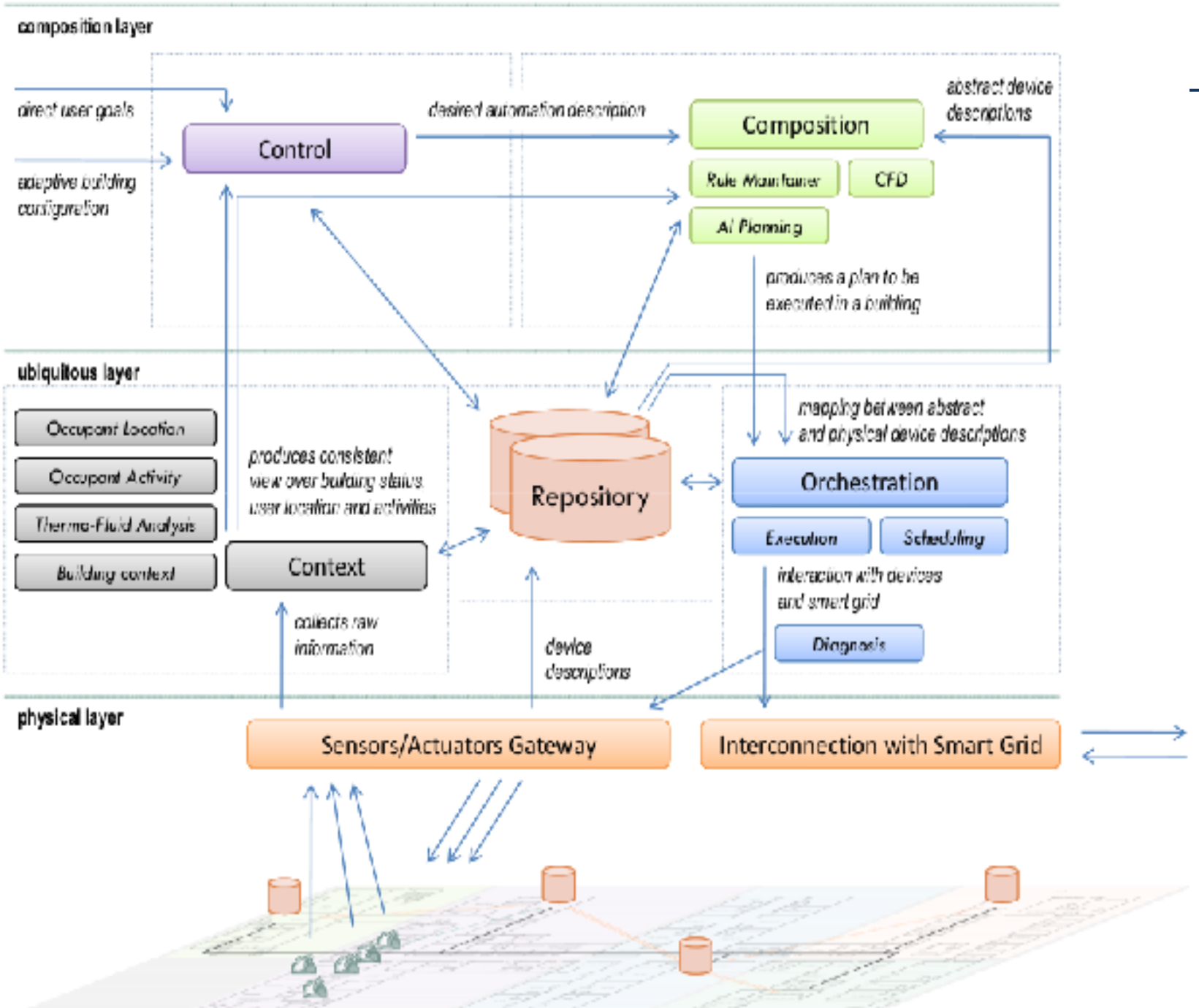
nest

Our results

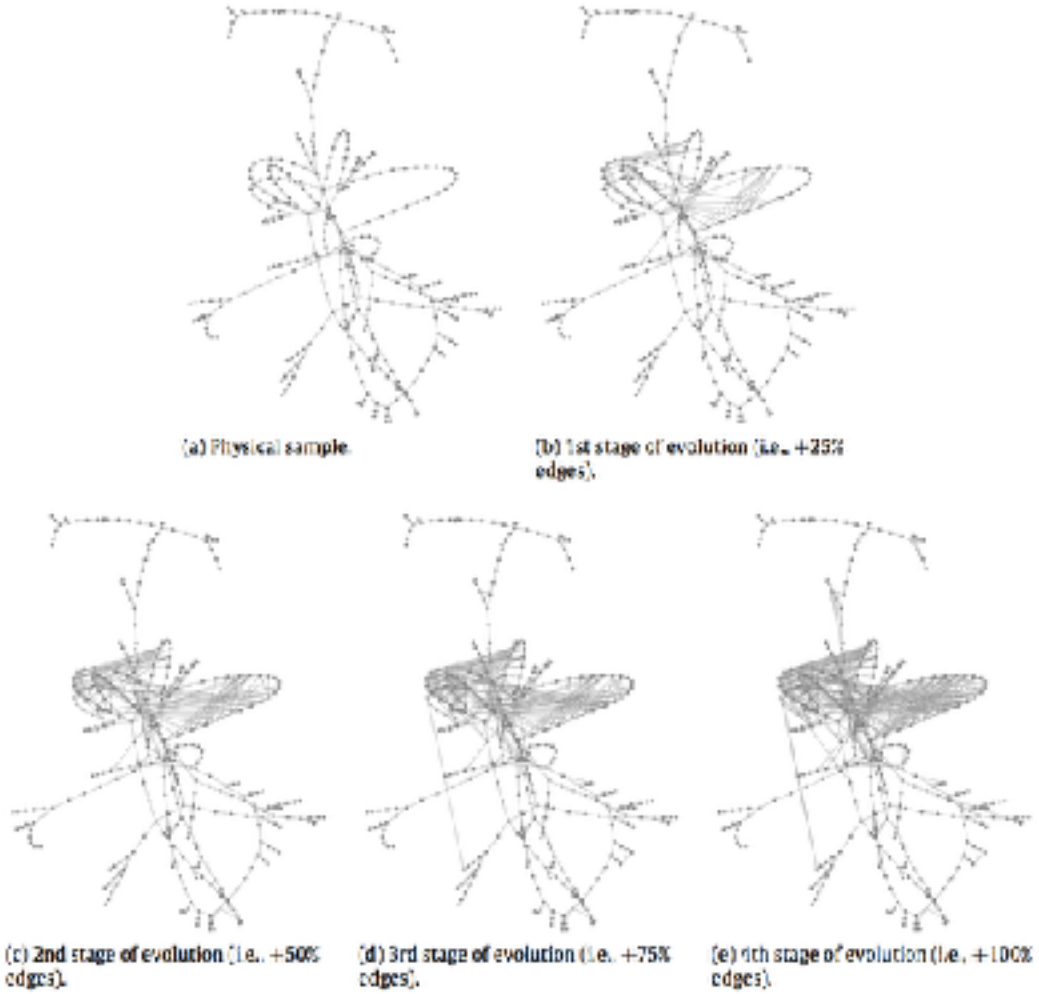
- *Smart Buildings:* scalable building IoT middleware
- *Smart Buildings:* low intrusive multi-activity recognition
- *Smart Buildings:* Artificial Intelligence Planning for Comfort Enhancement and Energy Optimization
- *Sustainable Buildings:* startup offering monitoring and building automation services
- *Smart Grids:* Complex network distribution grid modelling
- *Smart Grids:* Complex network evolution of the distribution grids
- *Smart Infrastructures:* IoT privacy preserving energy monitoring and cloud based optimization

Activity Recognition




composition layer
direct user goals
adaptive building configuration
Control
desired automation description
Composition
abstract device descriptions
Rule Maintainer
CFD
AI Planning
produces a plan to be executed in a building
ubiquitous layer
Occupant Location
Occupant Activity
Thermo-Fluid Analysis
Building context
produces consistent view over building status user location and activities
Context
Repository
mapping between abstract and physical device descriptions
Orchestration
Execution
Scheduling
interaction with devices and smart grid
Diagnosis
collects raw information
device descriptions
physical layer
Sensors/Actuators Gateway
Interconnection with Smart Grid

Distribution Grid Evolution Modelling



(a) Physical sample. (b) 1st stage of evolution (i.e., +25% edges). (c) 2nd stage of evolution (i.e., +50% edges). (d) 3rd stage of evolution (i.e. +75% edges). (e) 4th stage of evolution (i.e., +100% edges).

Fig. 2. Stages of evolution of medium voltage sample #6 following least distance strategy.

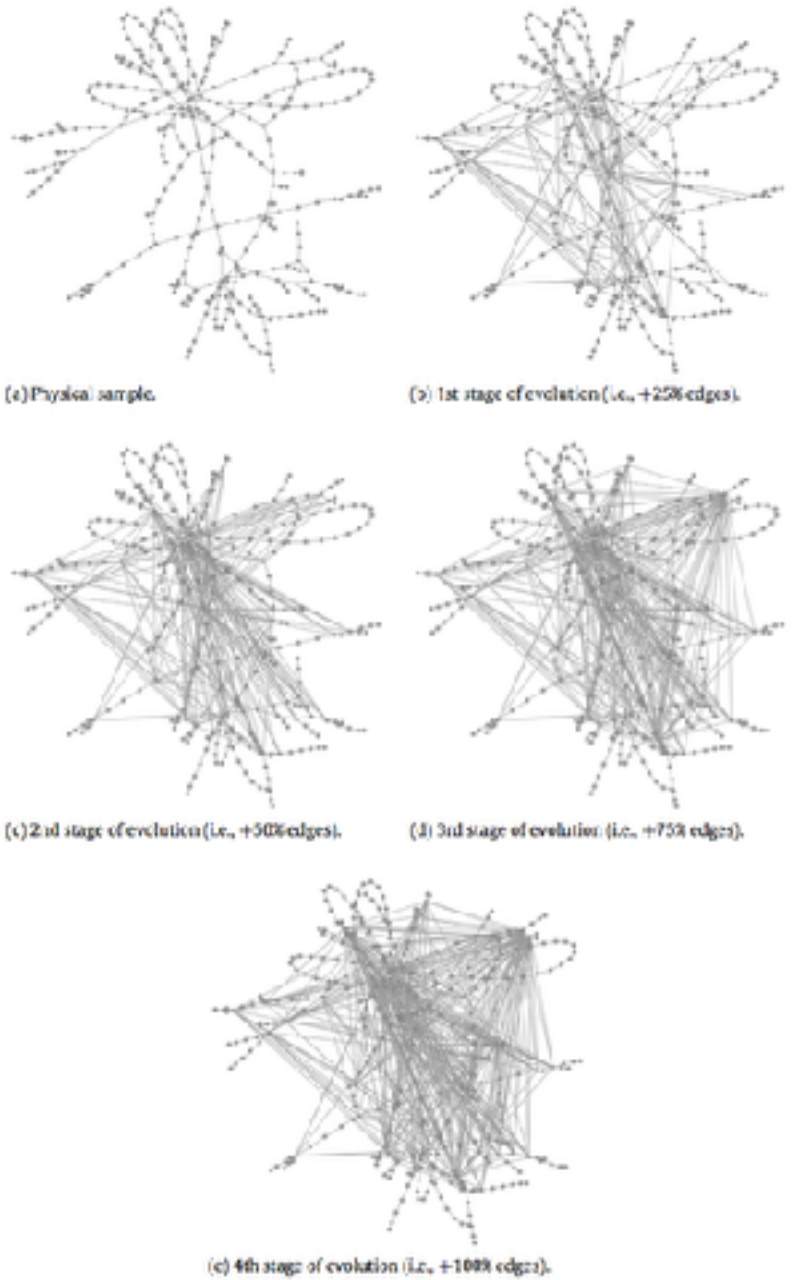


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Fig. 3. Stages of evolution of medium voltage sample #0 following the assortative high degree strategy.

Success story

The Bernoulliborg

Sustainable Buildings BV

gemeente Leek

GEMEENTE GROOTEGAST

gemeente BELLINGWEDDE

Gemeente Hoogeveen

Personal Research Agenda

A new Power Distribution Grid

Smart Meters
Local Coordination
Emergent Sustainable Behavior

Green People Support

Green Buildings

An interdisciplinary research agenda

- Computer Scientists
- Power Engineers
- Control Engineers
- Telecommunication Engineers

- Psychologists
- Economists
- Law experts

- …


Thank you!
When the Smart Grid takes a rest.

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