Lessons Learned from 25 Years of International Renewables Integration Consulting

energynautics
solutions for sustainable development

Dr. Dipl.-Ing. Thomas Ackermann

Energynautics Gmbh

t.ackermann@energynautics.com

Biography Thomas Ackermann

- **Diplom Wirtschaftsingenieur**
  - (MSc in ME and MBA) – Technical University, Berlin, Germany
- **MSc in Physics**
  - Otago University, Duniden, New Zealand
- **Ph.D. Electrical Engineering (Power System Deregulation and Distributed Generation)**
  - Royal Institute of Technology, Stockholm, Sweden
- **Founder and CEO of Energynautics, a German-based research and consulting company in the field of renewable generation and power systems;**
- **Consultant for Renewable & Grid Integration for the past 25 years/worked in 33 countries**
  - Abu Dhabi, Australia, Bahamas, Bangladesh, Barbados, China, Costa Rica, Denmark, Estonia, Ghana, Galapagos, Germany, Guatemala, Guyana, Honduras, India, Indonesia, Japan, Jordan, Kenya, Sweden, Mongolia, New Zealand, Norway, Oman, Philippines, Seychelles, Thailand, Tonga, Trinidad und Tobago, Turkey, Vietnam and USA
- **Lecturer Royal Institute of Technology**, Stockholm, Sweden (and Hector Business School, Karlsruhe)
- **Fulbright Schuman Scholar (2023) -** Visiting researcher at the Hawai'i Natural Energy Institute of the University of Hawai‘i at Mānoa (UHM) in Honolulu, Hawaii.

Energynautics based in Damstadt/Germany

Research and Consulting company the area of grid integration of renewables

Started April 2000

Services by energynautics

- Grid Studies
- Smart Grid Development
- Power Generating Unit Modelling
- Grid Code Development
- Grid Optimization Software ENAplan
- Measurement Campaigns
- Capacity Building
- Conference Planning

Energynautics Clients & Partners

energynautics International Work Experience

Recent German Aspects

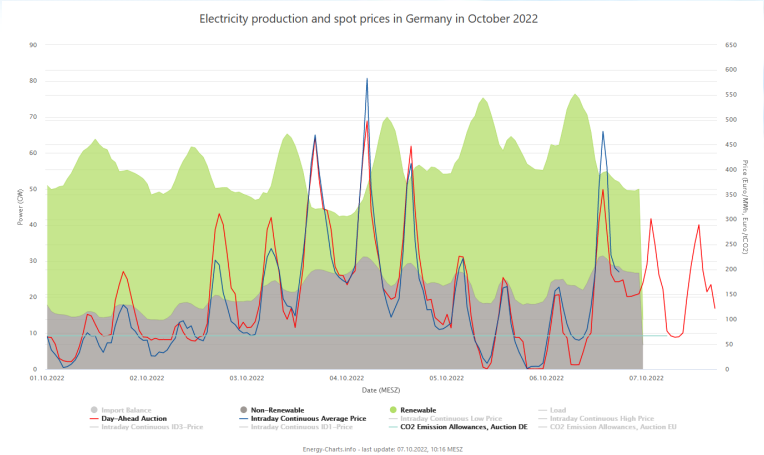
European Energy Crisis: Have Renewables Failed?

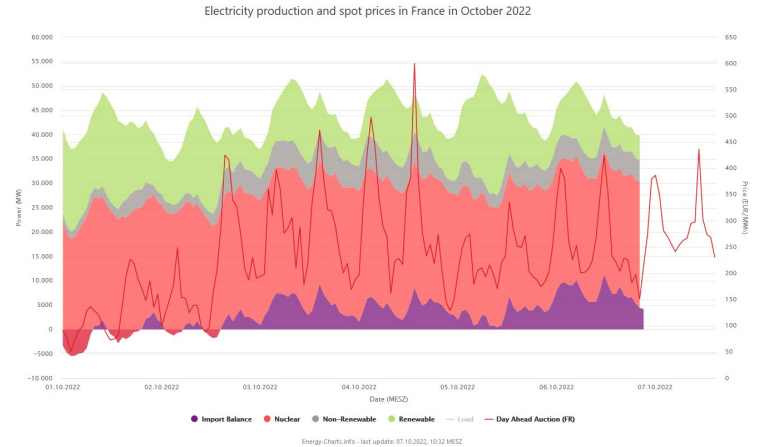
energynautics
solutions for sustainable development

… or at least that's what half the world seems to believe these days.

It's obviously not true, but that needs to be communicated more aggressively.

- RE stabilize prices and provide energy without reliance on fossil fuel imports.
- The crisis is multifactorial and a continuing reliance on large scale thermal generation is among the root causes:
  - French nuclear issues (up to 32 GW offline)
  - Shortage of gas
  - High gas and coal prices
  - Too little hydro availability





Germany is Bringing Back Coal…

energynautics
solutions for sustainable development

… or is it?

- A few mothballed coal units are being brought back online
- Temporary short-term measure in an acute Europe wide energy crisis
- No plans (so far…) to go back to coal in the long run
- No new investments in coal planned
- Misleading headlines are great ammunition for anti-RE propagandists… again, undermining worldwide decarbonization efforts

Time Table for Brown Coal phase-out in Germany

(Hard-coal phase-out to start 2027)

Blockname	Nettonennleistung [MW_{el}]	Endgültiges Stilllegungsdatum gemäß Anlage 2 zum KVBG
Niederaußem D	297	31.12.2020
Niederaußem C	295	31.12.2021
Neurath B	294	31.12.2021
Weisweiler E	321	31.12.2021
Neurath A	294	01.04.2022
Neurath D	607	31.12.2022
Neurath E	604	31.12.2022
Frechen/Wachtberg	120	31.12.2022
Weisweiler F	321	01.01.2025
Weisweiler G oder H *	663 bzw. 656	01.04.2028
Jänschwalde A	465	31.12.2028
Jänschwalde B	465	31.12.2028
Jänschwalde C	465	31.12.2028
Jänschwalde D	465	31.12.2028
Weisweiler H oder G *	656 bzw. 663	01.04.2029
Boxberg N und P	465 (jeweils)	31.12.2029
Niederaußem G oder H *	628 bzw. 648	31.12.2029
Niederaußem H oder G *	648 bzw. 628	01.01.2033
Schkopau A und B	450 (jeweils)	31.12.2034
Lippendorf R und S	875 (jeweils)	31.12.2035
Niederaußem K	944	31.12.2038
Neurath F (BoA 2)	1060	31.12.2038
Neurath G (BoA 3)	1060	31.12.2038
Schwarze Pumpe A und B	750 (jeweils)	31.12.2038
Boxberg R und Q	640 und 857	31.12.2038

* Wahlrecht

Timetable for the nuclear phase-out in Germany

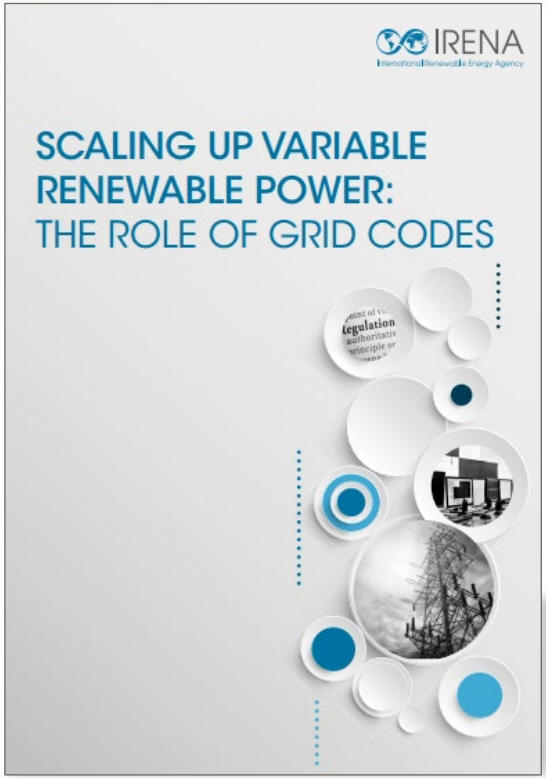
(Source: Kernenergie.de; E.ON)

CLEAN ENERGY WIRE

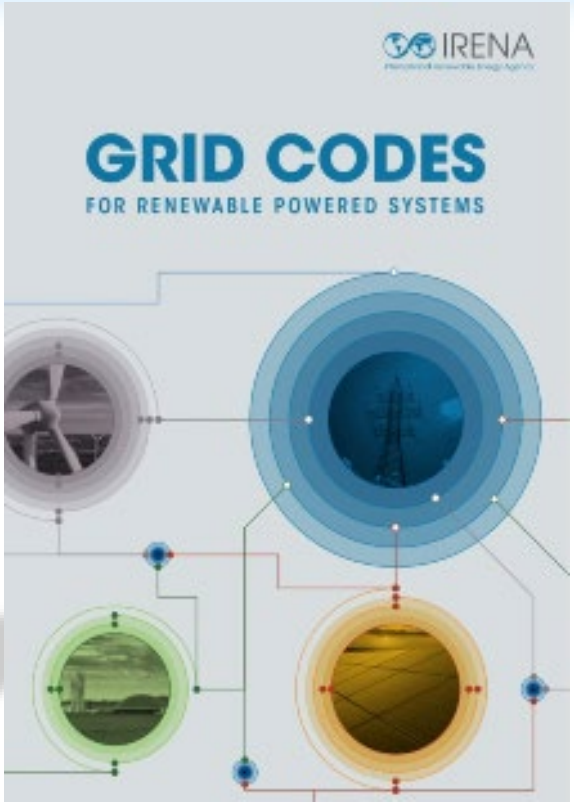
Reactors and net-capacity in MW	Date of closure	Operator
Unterweser: 1345 MW	6 Aug 2011	E.ON
Isar/Ohu 1: 878 MW	6 Aug 2011	
Grafenrheinfeld: 1275 MW	28 Jun 2015	
Isar Ohu 2: 1410 MW	31 Dec 2022	
Brokdorf: 1410 MW	31 Dec 2021	
Grohnde: 1360 MW	31 Dec 2021	
Phillipsburg 1: 890 MW	6 Aug 2011	EnBW
Neckarwestheim 1: 785 MW	6 Aug 2011	
Phillipsburg 2: 1402 MW	31 Dec 2019	
Neckarwestheim 2: 1310 MW	31 Dec 2022	
Biblis B: 1240 MW	6 Aug 2011	RWE
Biblis A: 1167 MW	6 Aug 2011	
Emsland: 1329 MW	31 Dec 2022	
Gundremmingen C: 1288 MW	31 Dec 2021	
Gundremmingen B: 1284 MW	31 Dec 2017	
Krümmel: 1346 MW	6 Aug 2011	Vattenfall
Brunsbüttel: 771 MW	6 Aug 2011	

Lessons learned - > What is relevant, the positiv or the negativ?

IRENA Report



2016



2022

Hosting Capacity Study New Delhi and Bhopal

GOAL

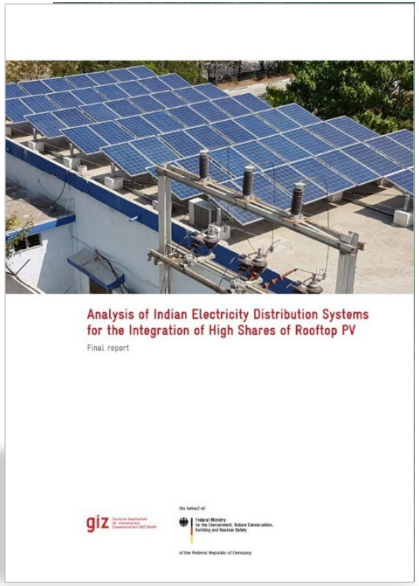
- Study on the integration of roof-mounted PV into Indian distribution grids

TASKS

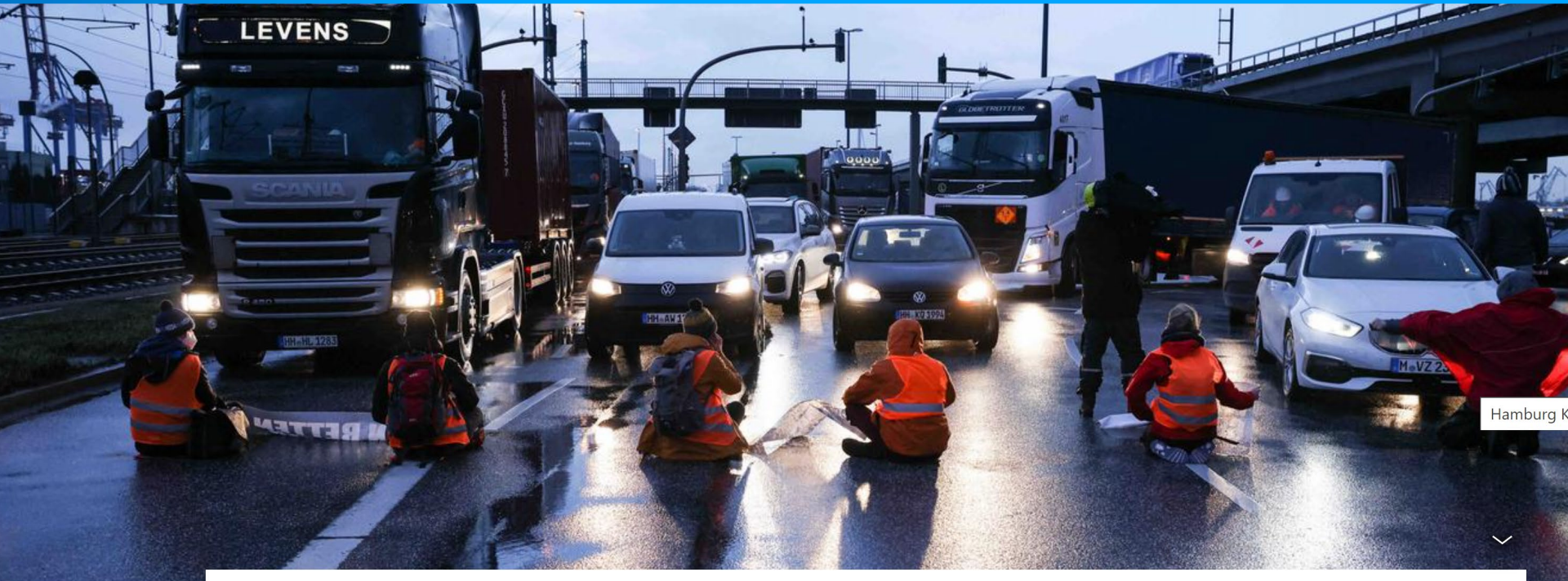
- Analysis of the legal and regulatory frameworks in India as well as more detailed technical and regulatory studies for two distribution grid areas
- Scenario development for PV distribution
- Distribution grid modelling, load flow calculations, storage optimization
- Studies on power quality and voltage control
- Organization of capacity building workshops for the operators

COMMISSIONED BY

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), German development agency



giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH



CLIMATE | GERMANY

Climate change activists block Hamburg port bridge

02/21/2022

"Uprising of the Last Generation" is protesting Germany's high level of food waste, among other

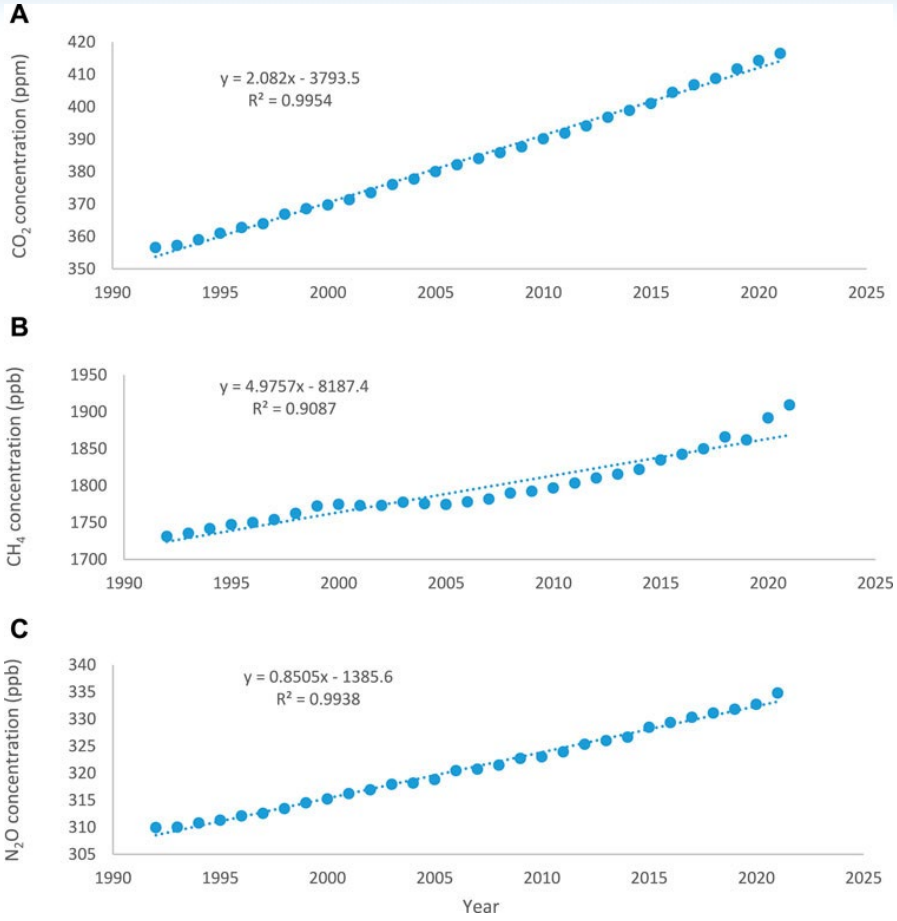
Rio de Janeiro (1992) to Sharm El-Sheikh, Egypt (2022)

The establishment of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, and the simultaneous UN Earth Summit in Rio de Janeiro, generated the international efforts to tackle climatic change. Over the years, the UNFCCC-Conference of the Parties (COP) has led the efforts in climate change mitigation and adaptation, with many sequential meetings across the world.

Three decades later, at the COP27 meeting in Sharm El-Sheikh, Egypt, it is evident that climate change impacts have substantially worsened.

Source: https://www.frontiersin.org/articles/10.3389/fenvs.2022.999788/full

Changes in Atmospheric Concentrations between 1992 and 2021



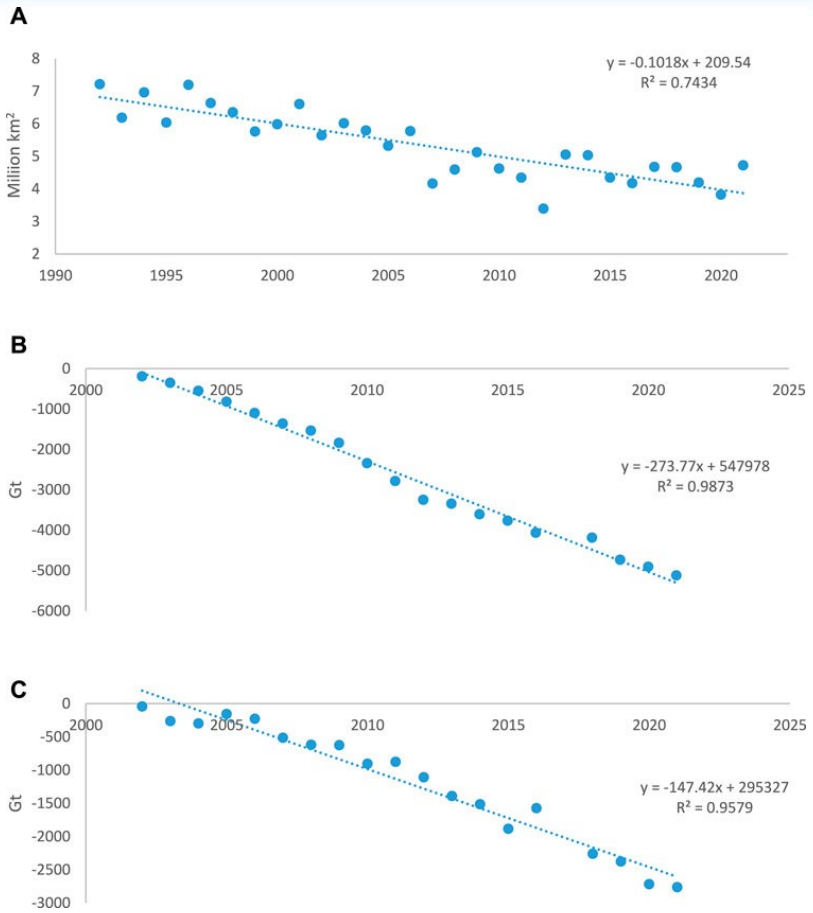
Changes in atmospheric concentrations of:

- carbon dioxide (CO_2: **(A)**,
- methane (CH_4: **(B)**, and
- nitrous oxide (N_2O: **(C)**

between 1992 and 2021

Source:
https://www.frontiersin.org/articles/10.3389/fenvs.2022.999788/full

Ice Sheet Retreat 1992 to 2021



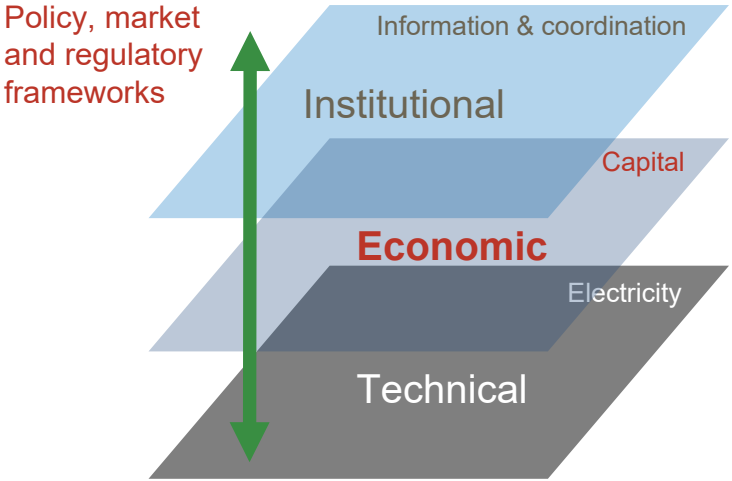
- **(A)**: Change in Arctic sea ice cover (in September) between 1992 and 2021;
- **(B)**: Greenland ice sheet cumulative mass variation between 2002 and 2021;
- **(C)**: Antarctica ice sheet cumulative mass variation between 2002 and 2021

Source: https://www.frontiersin.org/articles/10.3389/fenvs.2022.999788/full

(Experience Bad projects: Road Map project stopped)

Lessons learned - > Regulations are super important

System transformation requires holistic approach



Institutional – defining roles and responsibilities

Economic – market design, regulation, planning frameworks

Technical – operation of power system, safeguarding reliability

Policies, markets and regulatory frameworks link technical, economic and institutional aspects

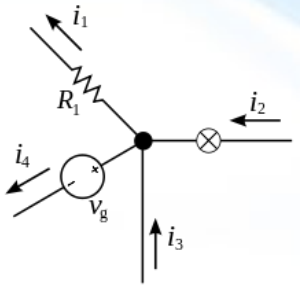
Relevance of Regulations

energynautics
solutions for sustainable development

Kirchhoff‘s laws

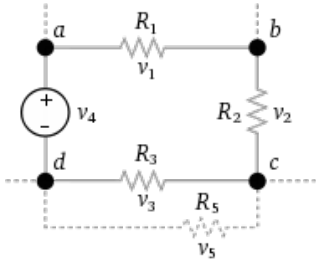
Kirchhoff‘s Law #1: Current

- The current entering any junction is equal to the current leaving that junction.



Kirchhoff‘s Law #2: Voltage

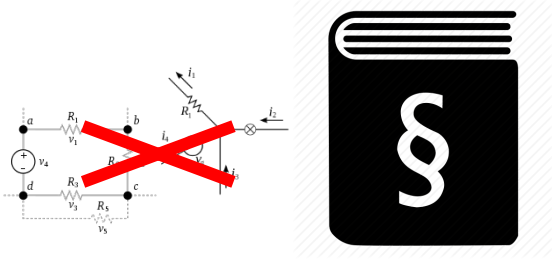
- The sum of all the voltages around a loop is equal to zero.



In the current power system landscape, Gustav Kirchhoff may as well have formulated a third law:

Kirchhoff‘s Law #3: Regulation

- No currents or voltages can do anything useful if the regulatory framework isn‘t right!



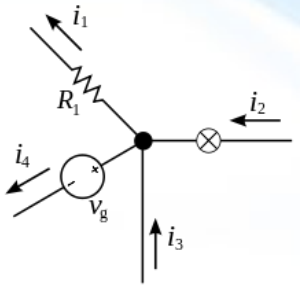
Relevance of Regulations and Utility Financing

energynautics
solutions for sustainable development

Kirchhoff's laws

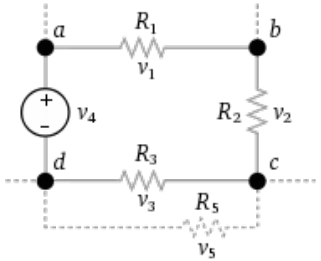
Kirchhoff's Law #1: Current

- The current entering any junction is equal to the current leaving that junction.



Kirchhoff's Law #2: Voltage

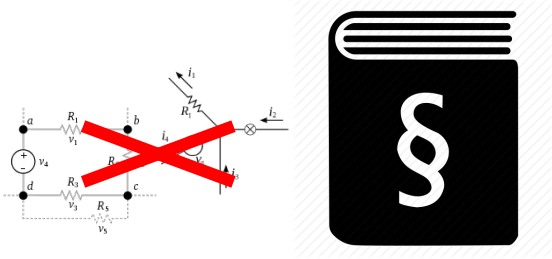
- The sum of all the voltages around a loop is equal to zero.



In the current power system landscape, Gustav Kirchhoff may as well have formulated a third law:

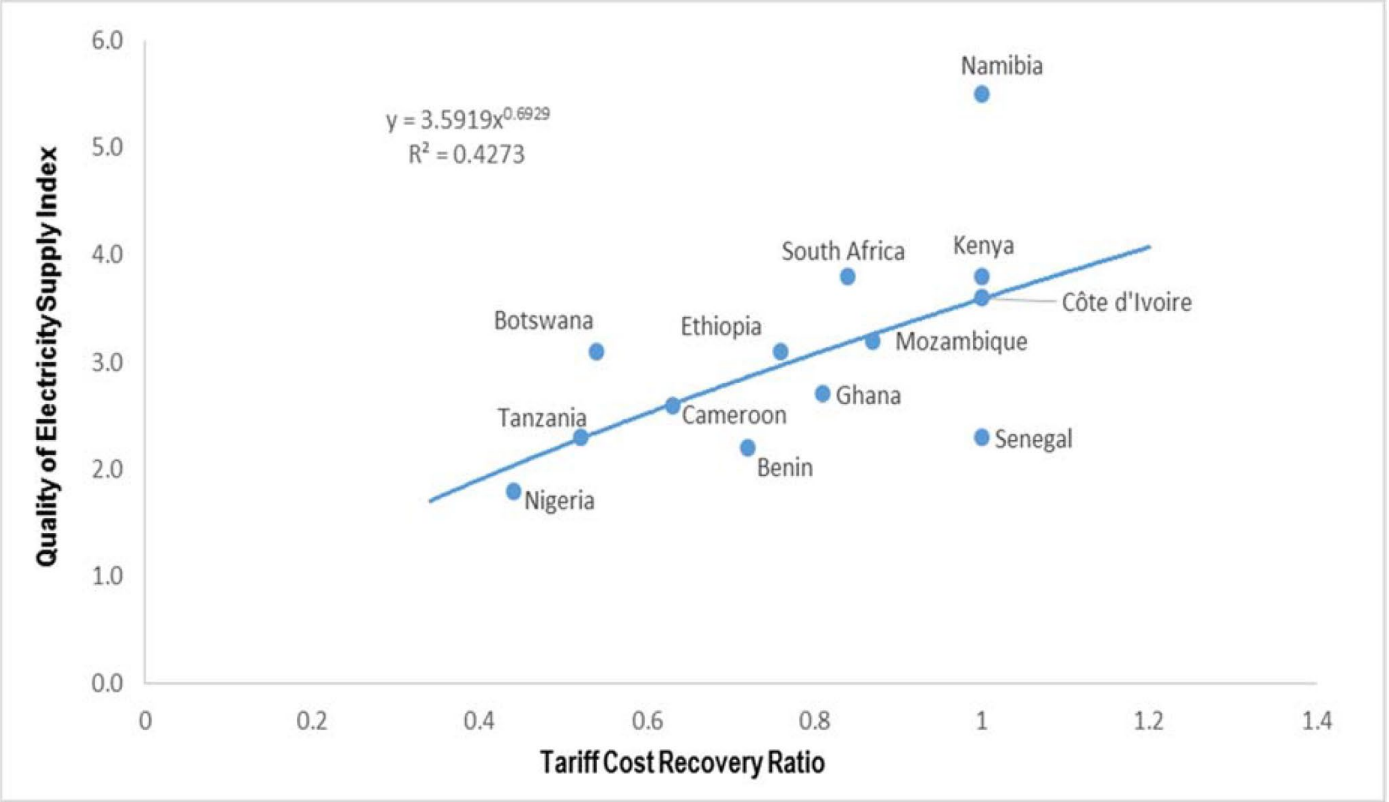
Kirchhoff's Law #3: Regulation/ Utility Financing

- No currents or voltages can do anything useful if the regulatory and utility financing framework isn't right!



(Example: Rates in Africa /demand drop due to Corona)

Tariff Cost Recovery Ratio versus Quality of Supply (2015)



Source: Worldbank

CONSUMER TARIFFS IN MANY DEVELOPING COUNTRIES

energynautics
solutions for sustainable development

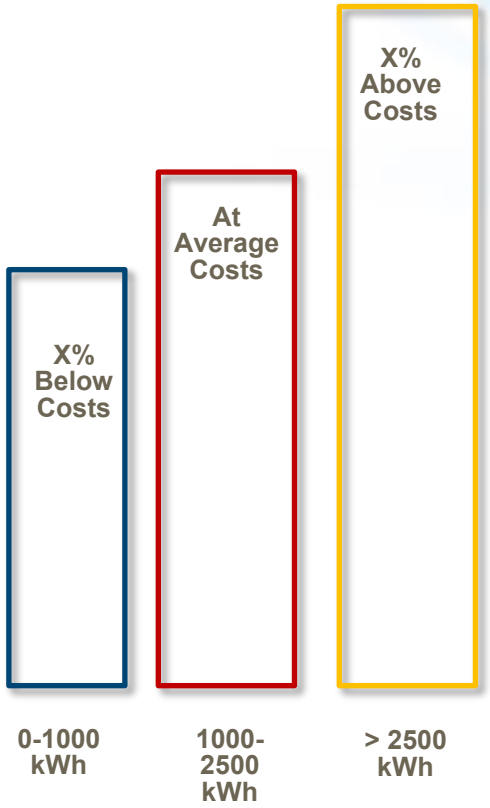
Structure prevalent in developing countries: Tariffs increase with consumption

Basic Idea:

- Large (wealthy, commercial) consumers subsidize small (poor, residential) consumers;

Issues with the introduction of net-metering:

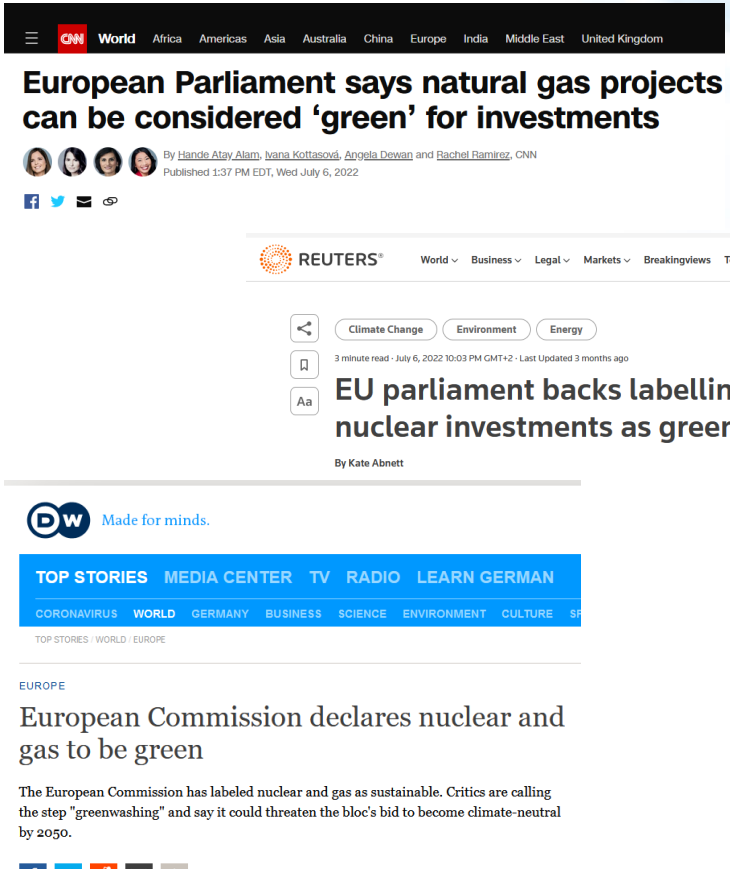
- Large (wealthy) consumers invest into rooftop PV systems; this way they reduce their consumption
  and drop to a lower tariff;
- Less consumers are available to subsidize small consumers
- Utility cannot recover its costs anymore!
- Utilities are fully or partly government owned, so they will not complain directly about the introduction of renewables, but:
- Utilities start to mention „technical issues“…
  „grid limits“ …. „grid instability due to renewables“



EU Green Washing difficult to explain …

The EU recently labeled investments in gas fired and nuclear generation as “sustainable”

- This decision is controversial
- “Sustainable” is not the same as “renewable” or “climate neutral”
- Labeling fossil gas as “renewable”, “green” or anything in that direction potentially undermines the worldwide energy transition and decarbonization efforts



World Africa Americas Asia Australia China Europe India Middle East United Kingdom

European Parliament says natural gas projects can be considered ‘green’ for investments

By Hande Atay Alam, Ivana Kottasová, Angela Dewan and Rachel Ramirez, CNN
Published 1:37 PM EDT, Wed July 6, 2022

REUTERS® World Business Legal Markets Breakingviews Technology Investigations

Climate Change Environment Energy

3 minute read · July 6, 2022 10:03 PM GMT+2 · Last Updated 3 months ago

EU parliament backs labelling gas and nuclear investments as green

By Kate Abnett

DW Made for minds.

TOP STORIES MEDIA CENTER TV RADIO LEARN GERMAN

CORONAVIRUS WORLD GERMANY BUSINESS SCIENCE ENVIRONMENT CULTURE

TOP STORIES / WORLD / EUROPE

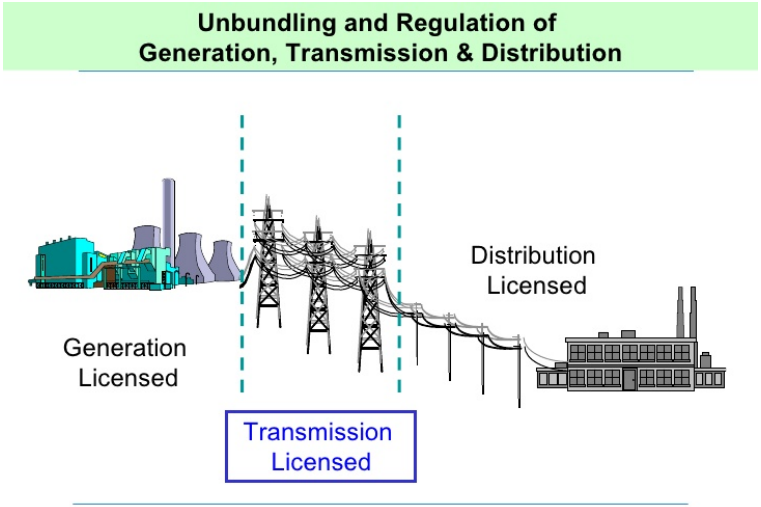
EUROPE

European Commission declares nuclear and gas to be green

The European Commission has labeled nuclear and gas as sustainable. Critics are calling the step "greenwashing" and say it could threaten the bloc's bid to become climate-neutral by 2050.

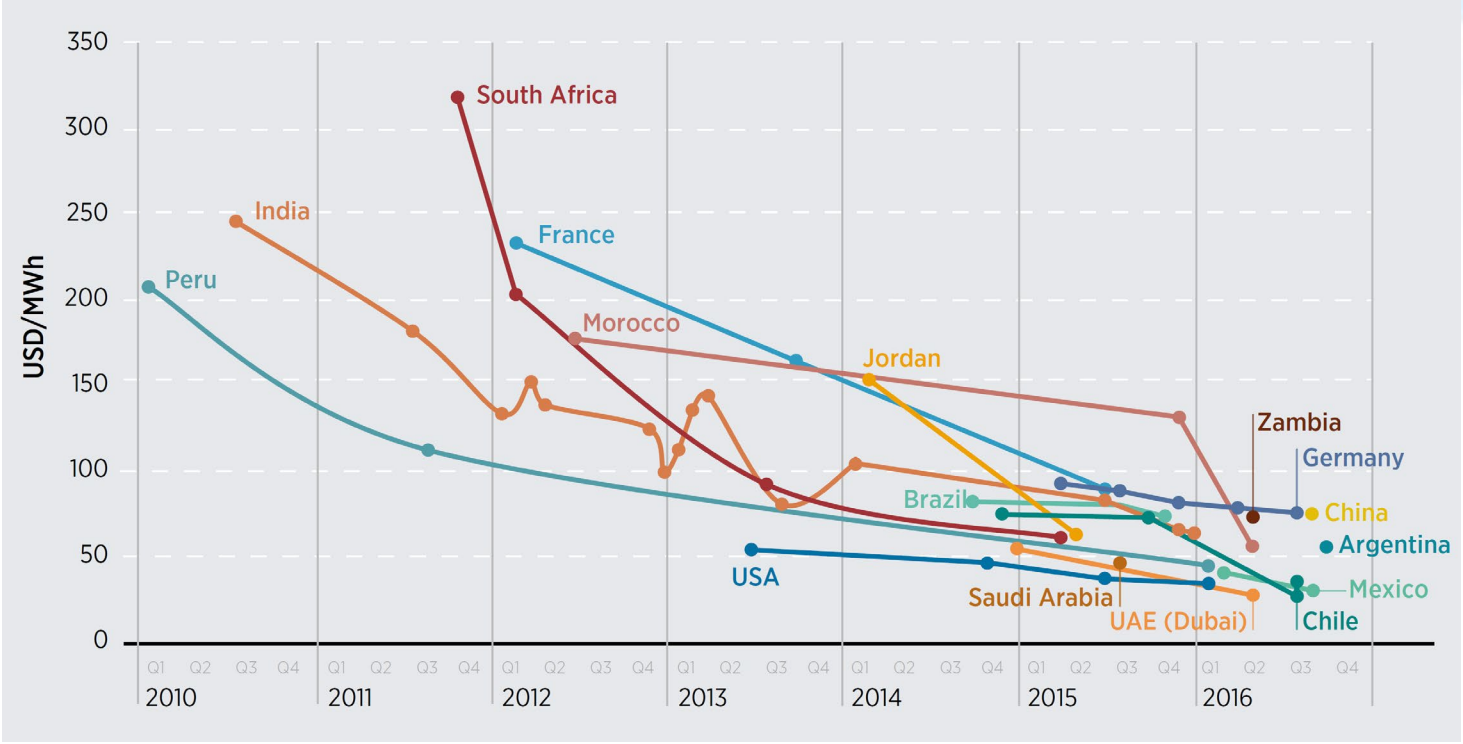
Lessons learned - >The real issues are often much more complicated

In many Countries the Power Industry is still a Monopoly!



The Process of Unbundling is often Happing parallel with VRE Introduction -> Renewable Auctions

Overview Renewable Auction Results



But grid integration is not about renewable energy costs anymore

Paradigma of international development activities

energynautics
solutions for sustainable development

Step 1: Country should formulate what they need!

Typical Solution: Roadmap

Step 2: International funding agencies provide funding - > international consultants are asked to do the study/with stakeholder involvement

Problem 1: Data collection, often perceived as control!, sometimes bribes expected..

Problem 2: Budget

Step 3: Strategie/training should ensure that next version of roadmap/relevant problems can be solved by local experts in the future

Problem: Trained local experts leave for better paid jobs

Example: Capacity Building canceled/stuff leaving

Denmark – Grid Upgrades between 2010-2020

Extra >600 MW HVDC connection to Norway in 2010

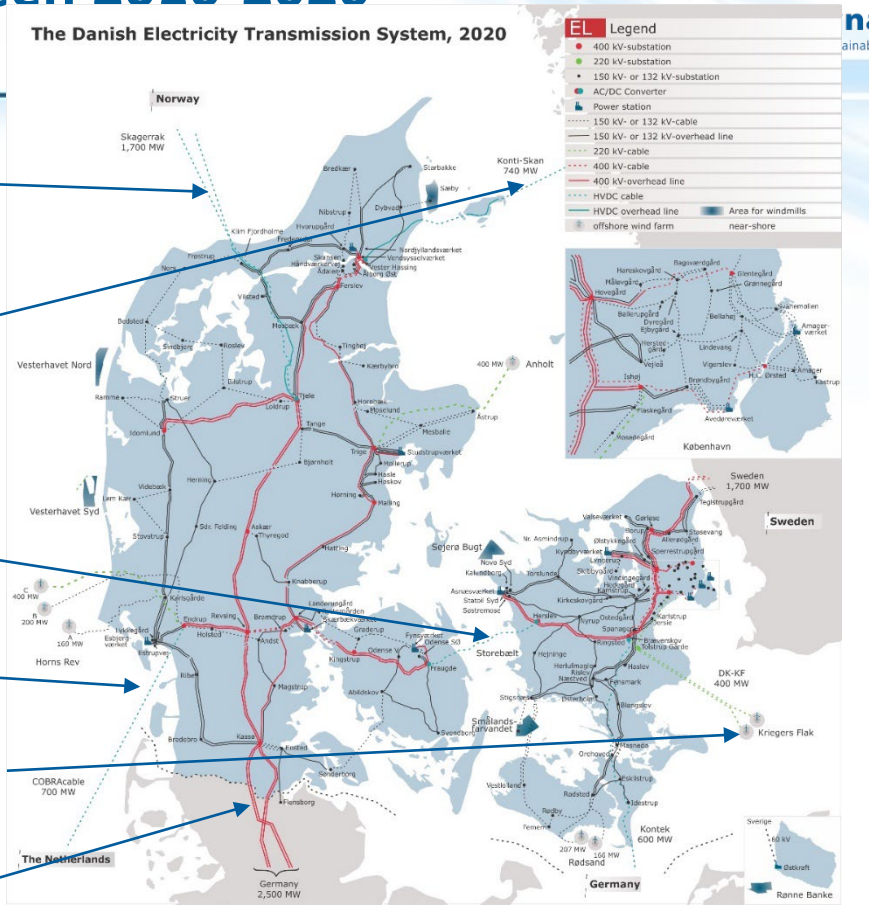
Upgrade of HVDC line to Sweden to 740 MW (plus 200 MW)

New 600 MW HVDC connection over The Great Belt by spring 2010

New Connection to Netherlands (700 MW)

New 400 MW to Germany (offshore)

Capacity Doubled to Germany (onshore)



Africa Continental Power System Masterplan

It may also interest you:

SPLAT Models for Africa

Clean Energy Corridors

Renewables Readiness Assessments

CONTACT US
Send a message

Overview Training week-1 Training week-2 Training week-3

Overview

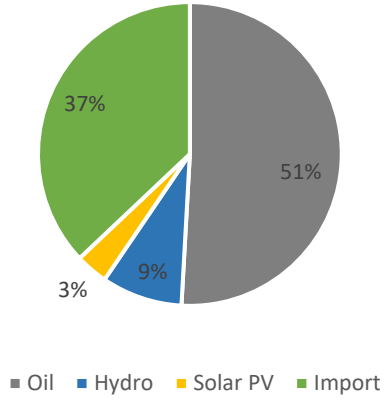
African Union has launched the Africa Single Electricity Market (AfSEM) on 3rd June 2021. Implementation of AfSEM will be suppor
the Continental Power System Masterplan (CMP) currently being developed by the African Union Development Agency (AUDA-NE
Together with the IAEA, IRENA is supporting the CMP initiative as officially endorsed modelling partner (IRENA press release).

IRENA's CMP support is a multi-year programme under the aim to establish a long-term continent-wide planning process for powe

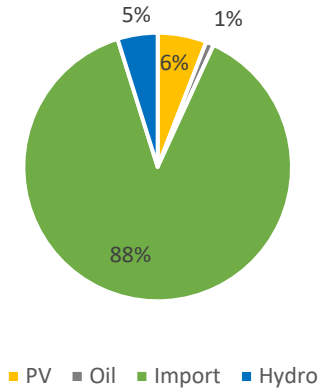
Burkina Faso

- Low income country with GDP (2019) $14.13 billion;
- Population in 2019 was 20.32 Million, estimated to reach 45 Million in 2050;
- Electrification rate: 20% with 66% of the urban and 3% of the rural population;
- Offically installed capacity around 550 MW, Cost of production at $0.22-0.25 USD/kWh
- Around 37% of the electricity is imported from neighbouring Ivory Coast. New transmission interconnections are also near completion to import electricity from Ghana

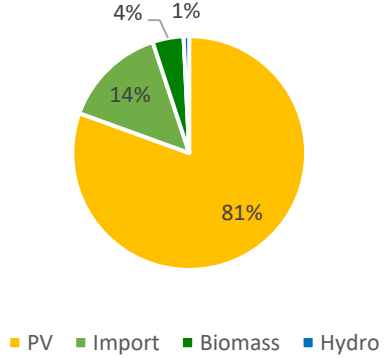
2017 Electricity Generation Mix: 1741 GWh



2030 (a) Electricity Generation Mix: 8830 GWh



2050 Electricity generation mix: 345000 GWh



27 GW by 2050

Ideas towards a solutions?

Not purchase of grid systems/Colonialism (Germany)

Renewable IPPs help to reduce the complexity for TSOs/DSOs (I)

- **Virtual Power Plants (Germany has around 40 GW)**

Combination of a large quantity of small distributed energy resources and demand response

All connected to the same grid

Controlled via a communication system

Benefits:

- Flexibility - If primary resource is not available, another type of generation can assist
- Higher reliability due to distributed risk
- Added value through controlling previously uncontrolled resources

Requires:

- (Complex) Optimization
- Secure Communication

Problem: No Markets/What incentives are needed – Task for G-PST?

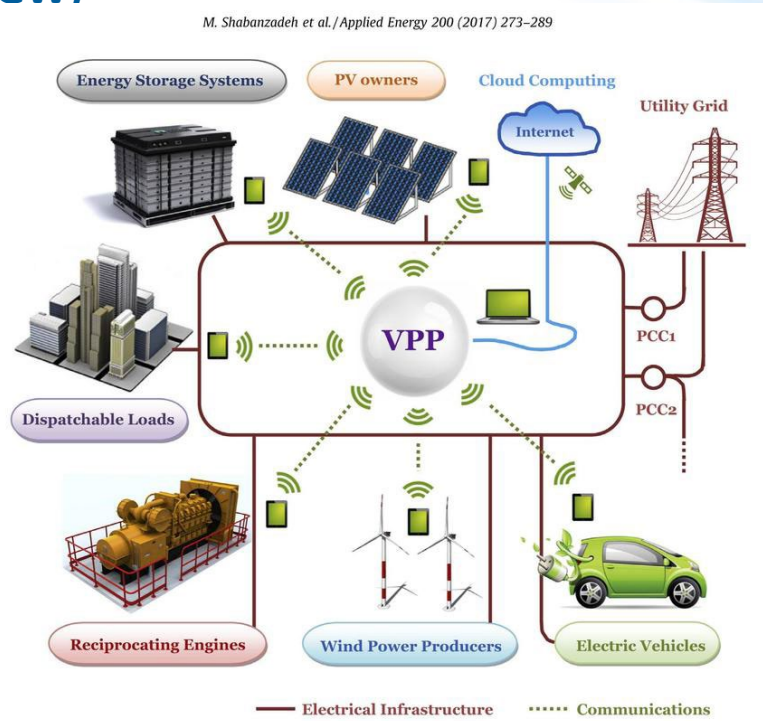
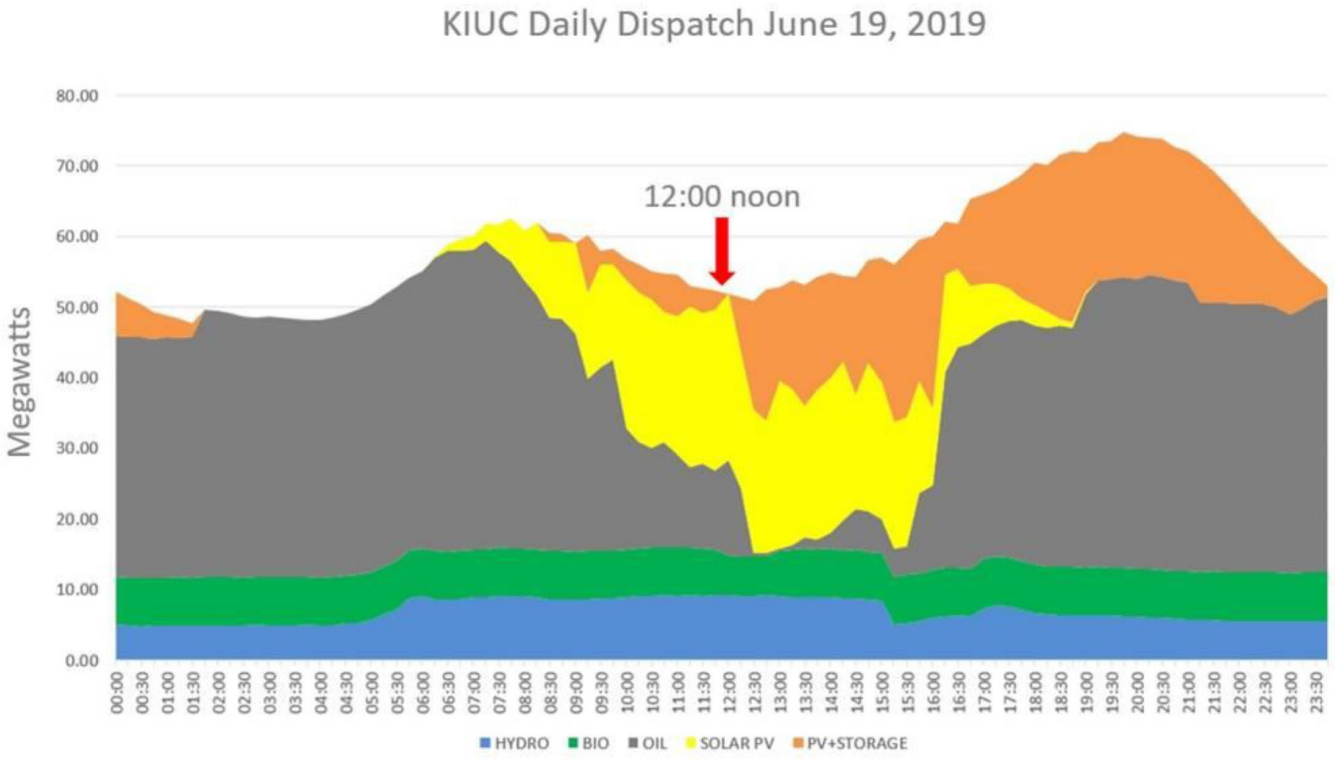


Fig. 1. A vision for VPP as an aggregator of heterogeneous DERs.

Renewable IPPs help to reduce the complexity for TSOs/DSOs (II)

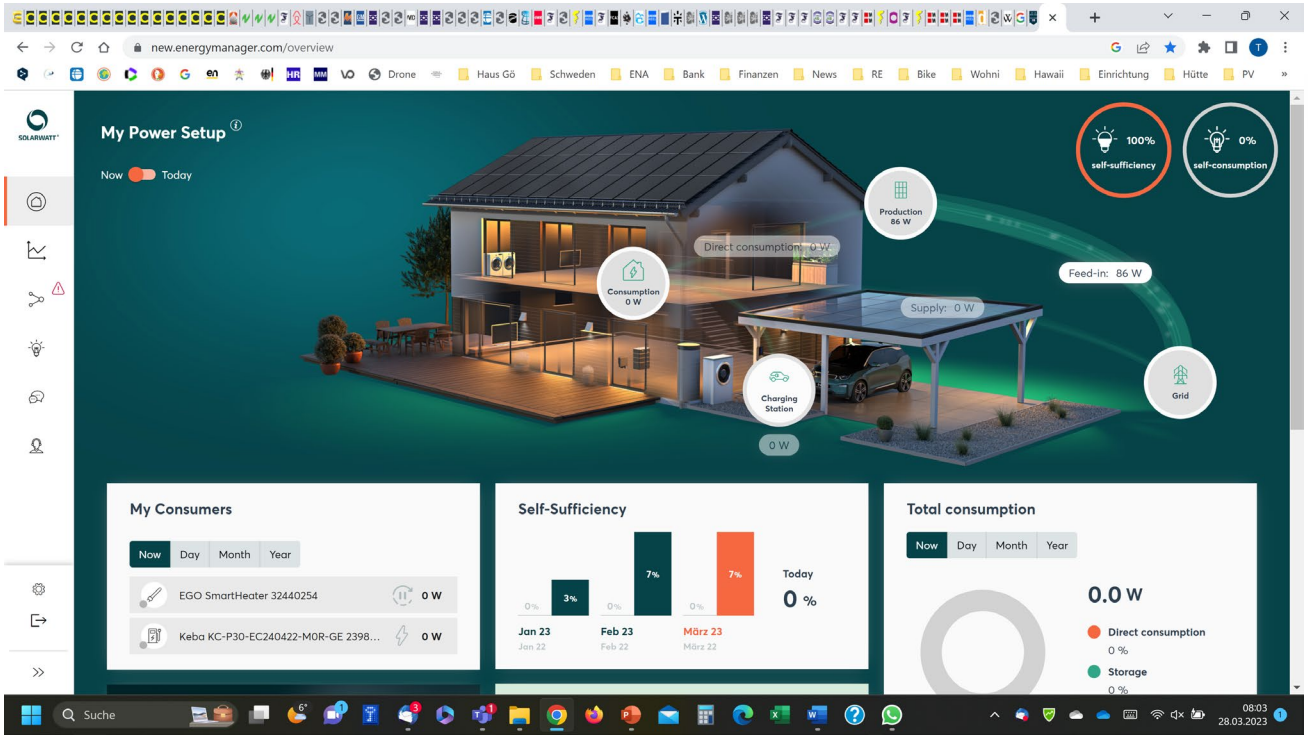
- **Hybrid Power Systems with BESS/4 hours storage (Hawaii)**



PPAs

Renewable IPPs help to reduce the complexity for TSOs/DSOs (III)

- **Local Energy Management Systems for distribute generation**



Feedback to..!

energynautics
solutions for sustainable development

Dr. Thomas Ackermann
Chief Executive Officer

t.ackermann@energynautics.com
+49 151 22 66 19 55

energynautics
solutions for sustainable development

ORGANIZED BY ENERGYNAUTICS