On Power System Paradigm Opportunities and Challenges

An African Perspective

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egi elia grid international

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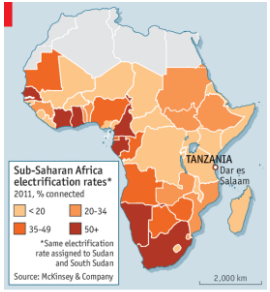
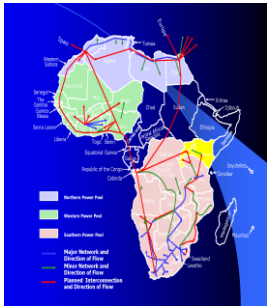
Introduction

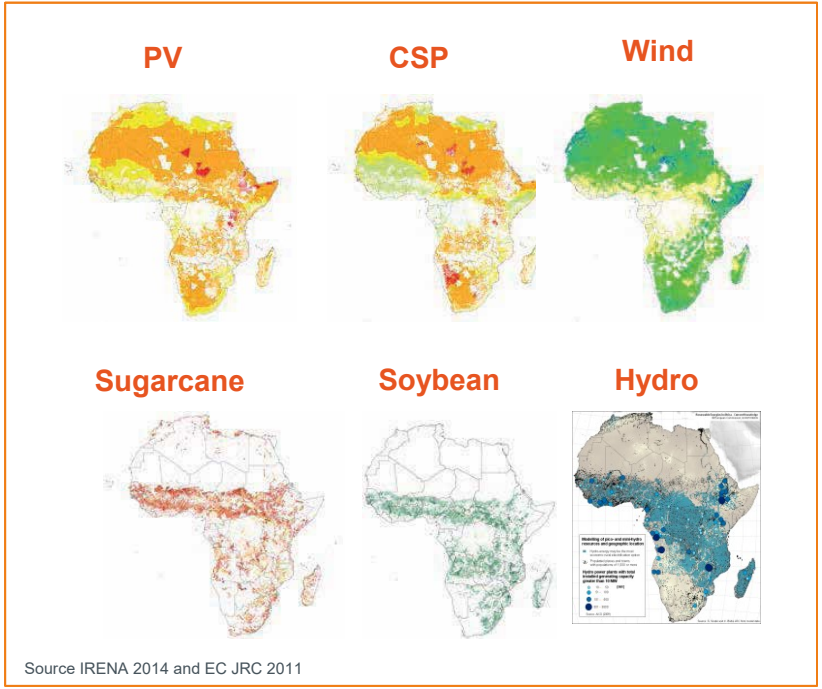
Africa has ambitious targets



Electrification rates



System interconnection



Source IRENA 2014 and EC JRC 2011

Toward Electricty Sustainable Africa:

- Unleach RES potential
- Reliable Electricity to all
- Affordable Electricty to all

Sustainablity goes beyond RES integration: Installing PV's while the system is not reliable nor cost-efficient is not sustainable on the long run!

Where to head?

External Constraints

- Extreme growth in **power demand**
- Impressive demgraphic growth
- Need for acces to electricty and **higher living standards**

- Lack of attractiveness for investors
- Limited **financial ressources**
- Tariff reduction and **loss of revenue**

- **Climatic challenges** and scarcity of conventional ressources
- Need for transparancy and **long term vision**

Internal Constraints

- Low grid **reliability** and Lack of **generation adequacy**
- Lack of usuage of interconnections

- Management of both old and brand **new infrastructures**
- Missing **Observability** and information
- High diversity of existing and new **infrastructures**

- Large territorial areas lacking **harmonization**
- Need of electrification of **rural areas**

Possible Visions…

Bulk System Development:

Asset management strategy
Cross-border interconnection
HVDC based backbone network
Energy Market and balancing Integration
- Cost-efficient System Adequacy
- Benefit from high RES potential regions
- Social welfare maximisation

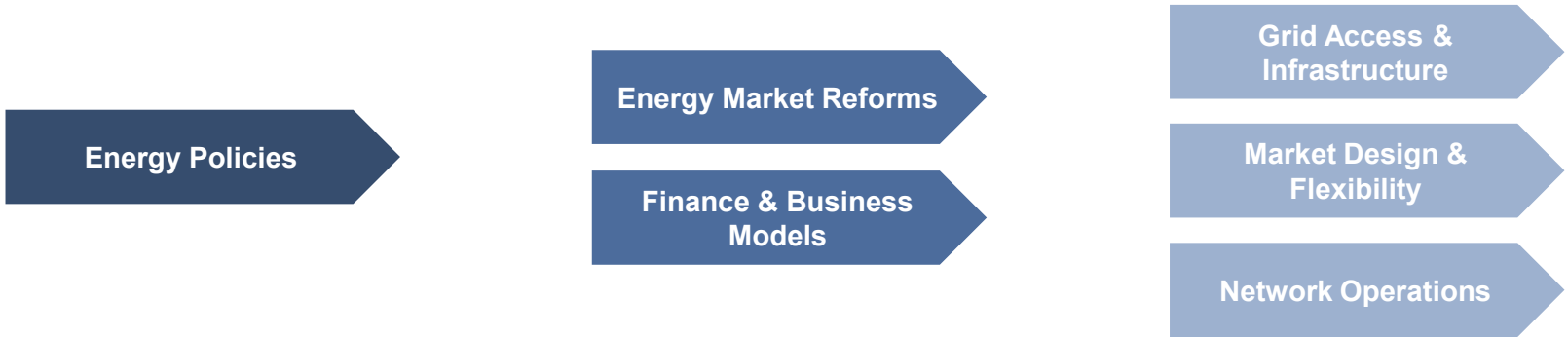
Decentralized System Development:

Asset management strategy
Production closer to demand
Smaller RES integration
Microgrids dominant electrification vector
- Cost-efficient RES integration
- Cost-efficient rural electrification
- Rural economic development

.....

The electricity sector must evolve to fully leverage sustainability

EGI's Framework encompassing electricity system paradigm

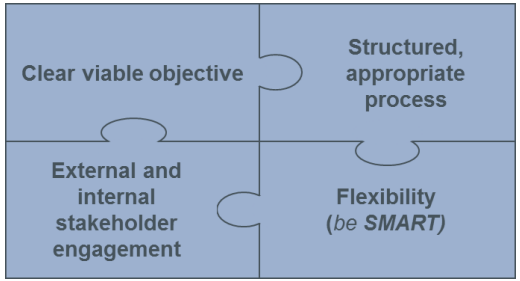


There is no miracle standard approach, every country have its own characteristics a systemic approach is needed to leverage sustainability in transparent, flexible and cost-efficient manner.

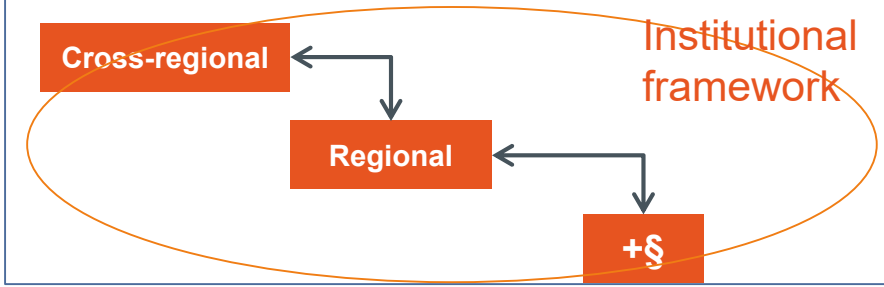
Setting strategic targets

Why co-shaping strategic targets?

1 Set targets efficiently



2 Fix targets into institutional framework but keep them flexible



Create RES policies to meet objectives

1. Answer „the why“, „ the what“, „the when“, „the which“ and „the how“ to create RES targets:
   - Electrification targets
   - *Diversification of the energy portfolio*
   - Cross-border market integration
   - RES penetration targets (utility/distributed)
   - *Public private partnership*

Against Long-, mid- and short-term

1. Break down goals and directives into concrete laws and allow
   - Adjustments on local fit
   - or readjustments after time

Re-designing of the power sector

Why consider legislative structural reforms ?

- Generation
- Transmission
- Distribution
- Retail

Introduction of competition: *stimulate fair & competitive energy prices*

Increase efficiency of the network: *Sharpen the focus of each business, clearer incentives to improve business (regulation), Transparency*

Enabling privatization and new investors

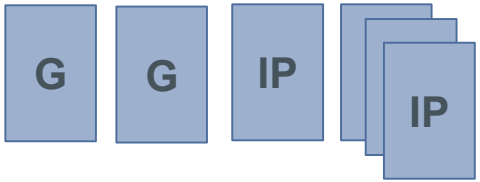
Opening to new entrants

Introduction new technologies

While minimizing drawbacks
Transaction cost, Investment risk, Lost economies of scales and scope

Structural reforms to leverage RES integration

1 Investor engagement



2 Support schemes

Legislative measures

Fixed feed in remuneration vs. tender

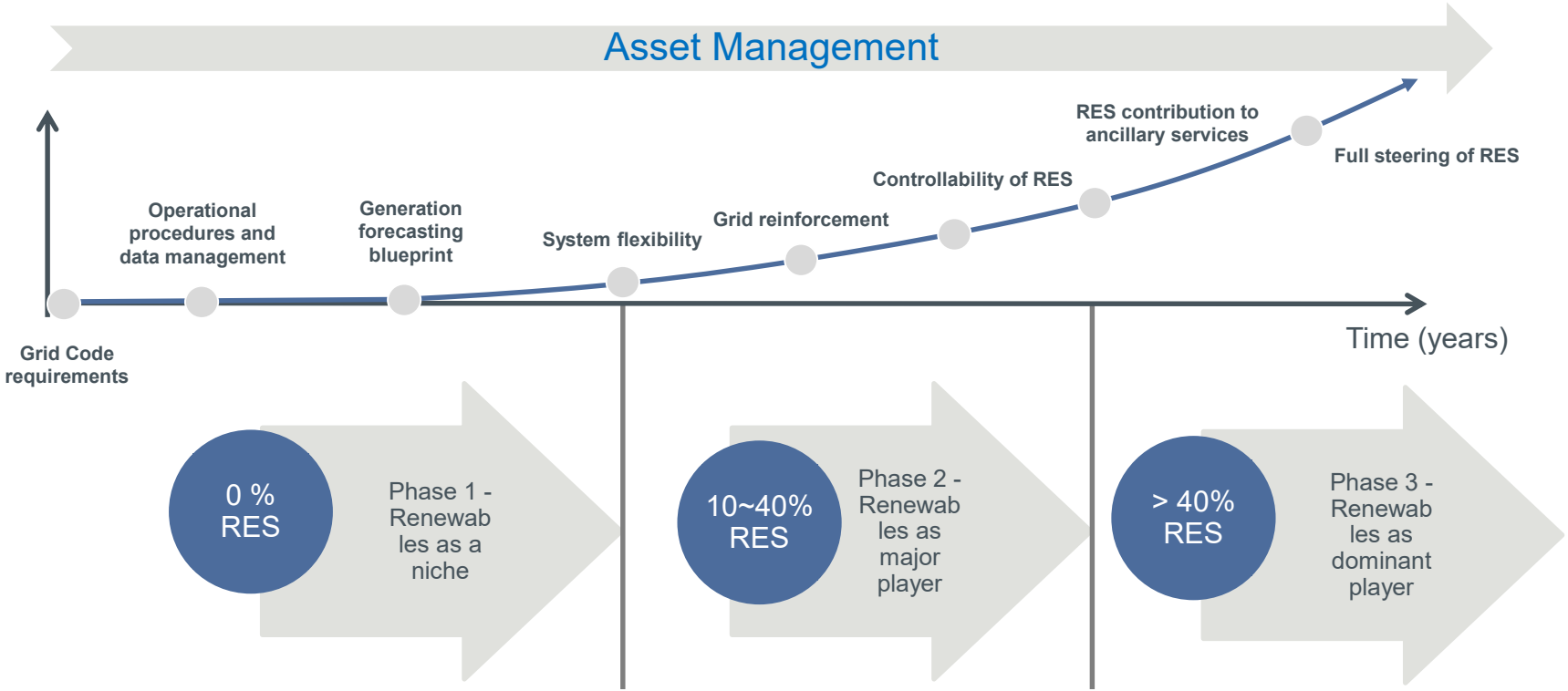
3 Manage generation

Efficiently introduce RES to the market

1. *Opening to investors*
   - *Application of PPA to IPP*
   - *From PPA to open market-based investments*
2. Attract investors by ensuring support schemes
   - *Demand pull, such as tendering*
   - *Supply push, such as tariffs*
   - RES leasing schemes
3. Decide how to manage generation
   - *Is there a need to create/adjust markets structures?*

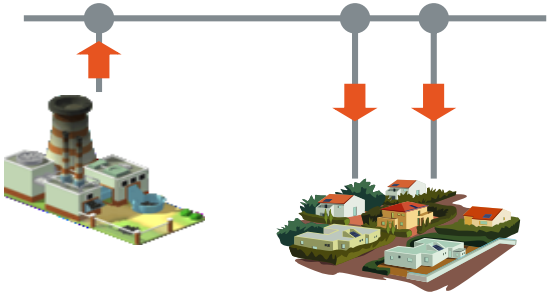
Transformation of the power system

System transformation: when RES integration increases, new challenges need to be mastered



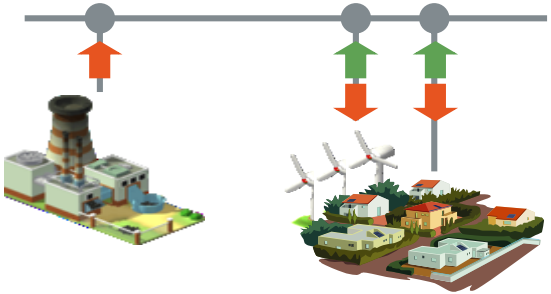
European perspective on future infrastructure

Until 2000
Central generation



Grid capacity needed to deliver energy from central power plants

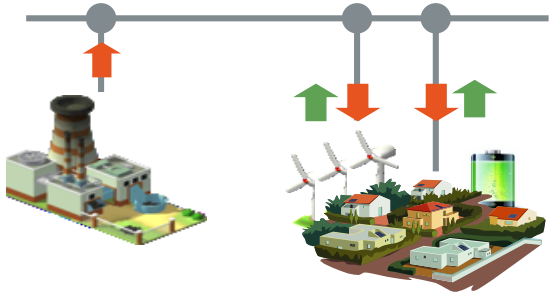
2000 – today
Rise of decentral generation



Grid capacity needed to...

- ...evacuate excess energy when low consumption
- ...deliver energy when there is no wind or sun

Tomorrow?
Rise of decentral islands



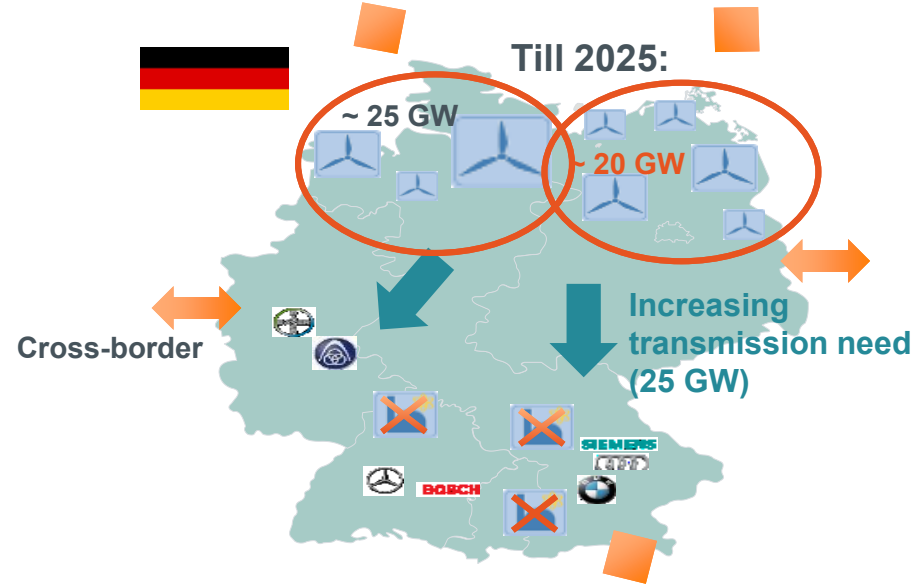
Grid capacity needed when...

- ...stored energy is insufficient to meet demand *(e.g., winter)*
- ...production exceeds storage capacity *(e.g., summer)*

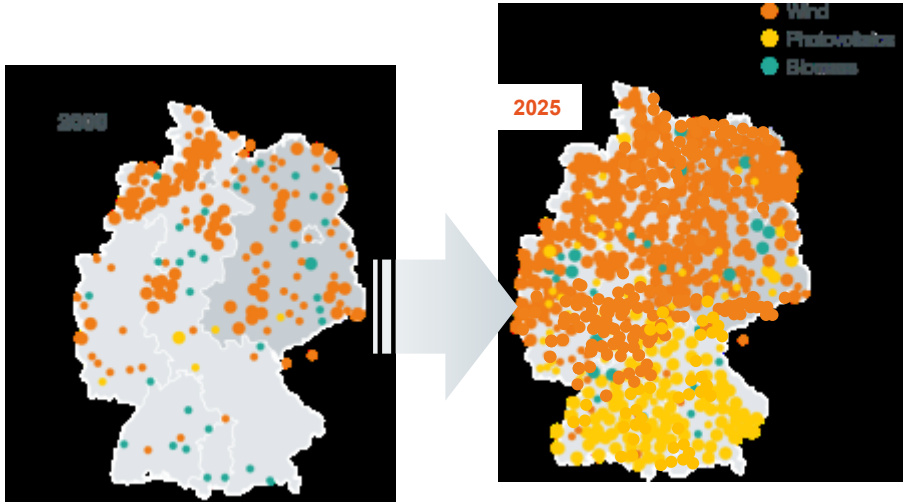
Both transmission and decentralized investments are needed in Europe

RES and grid development the German example

Bulk transmission level



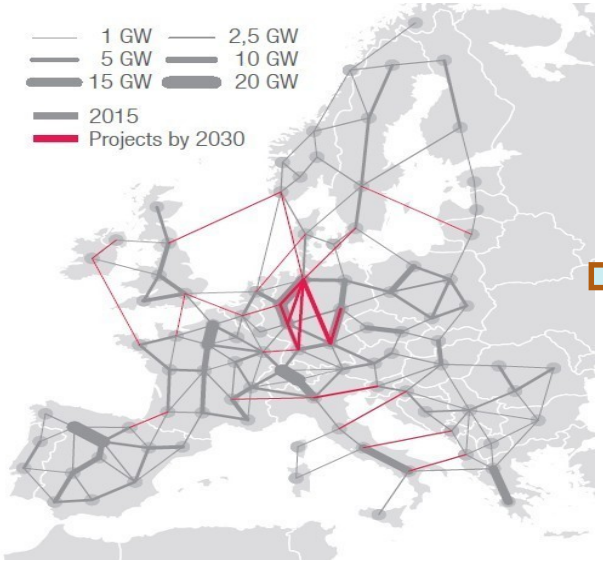
Decentralized level



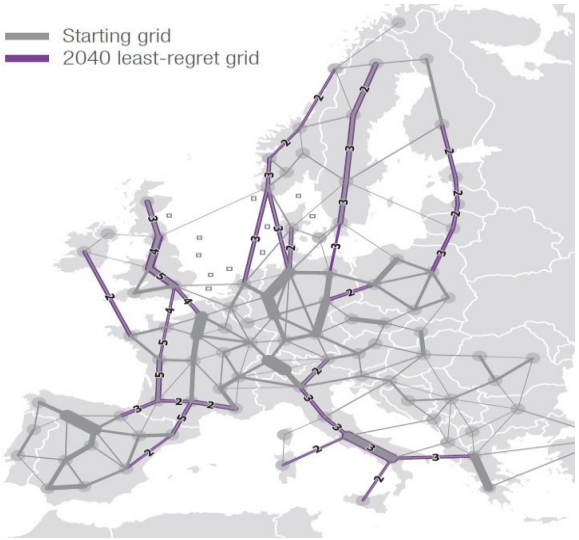
Development of 3 North-South HVDC corridors
Reinforcing backbone transmission network
Reinforcing cross-border interconnections

Massive DG RES (currently more than 1.6M small units)
Substantial investments at distribution level

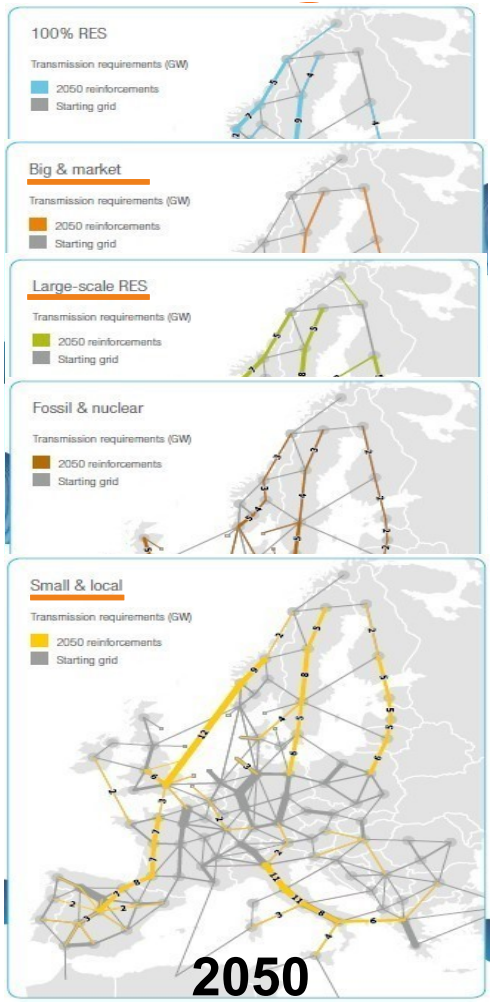
Pan-European: Network Development Plan



2030



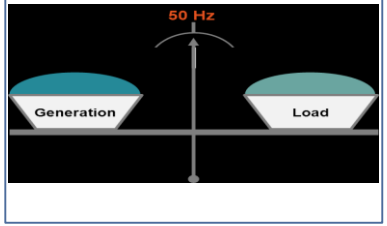
2040



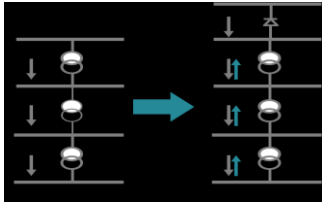
2050

RES impact on Power system operations

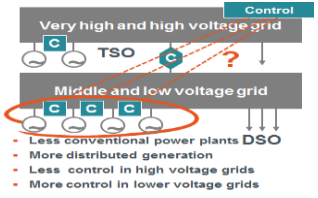
1 Balancing



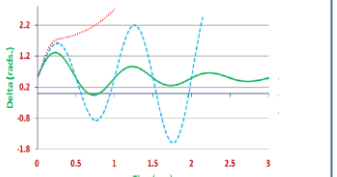
2 Coordination



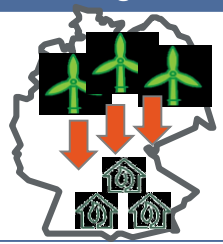
3 Voltage control



4 Stability



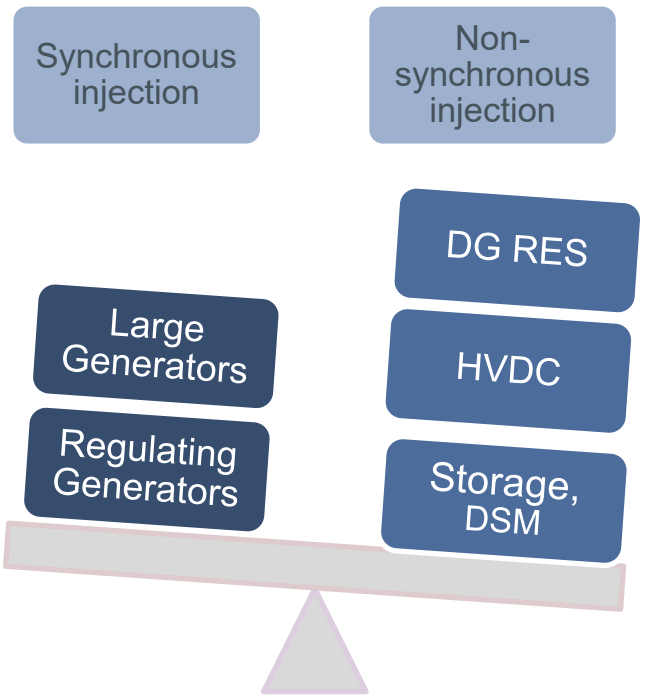
5 Grid congestion



Complex system operations

1. **Balancing and frequency control**
   - Volatility and poor predictability challenges forecasting
   - Lack of conventional regulating units changed structure of control power and participation
2. **Coordination**
   - Operational challenges with scattered generation resources: complex real time data management
   - Lack of observability at lower voltage levels
3. **Voltage control**
   - Lack of Voltage regulating units and
   - Voltage during low demand and high RES infeed
4. **Angular stability**
   - Lack of rotational inertia and higher RoCoF
   - Lower short-circuit level and angular stability issues
5. **Grid congestion**
   - Congestion impact – due to distance between generation and load as well as in the distribution level

New generation trends and impact on operations



Non-synchronous injection

This reduces **system inertia** and **short-circuit power**;

Load Frequency and voltage control capability issues;

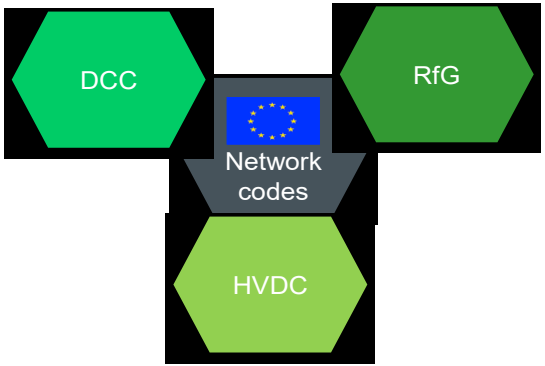
Angular stability: loss of synchronism of the remaining synchronous generation.

Scattered distributed generation

Increase the **complexity of real time** system controllability and operational planning;

Increase the **data management** for real time operation (observability) and grid development.

Harmonized state of the art grid codes



Grid Connection Related Codes

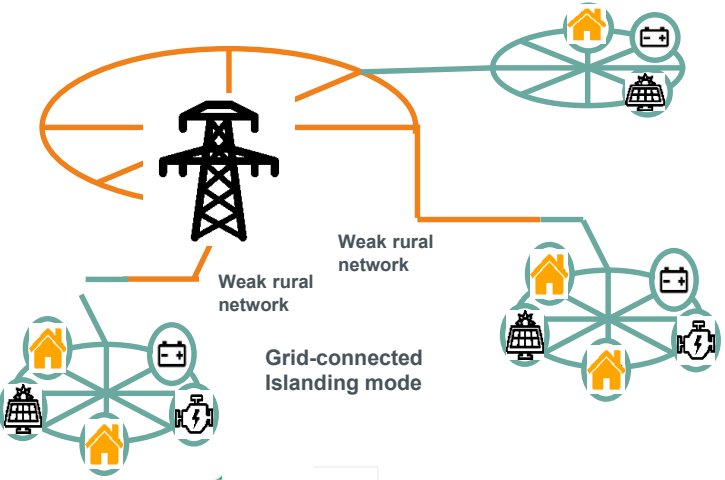
Integration of new market players and leveraging flexibility

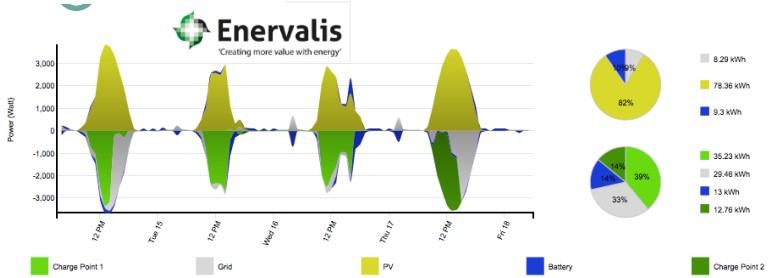
- Demand units as significant Grid User
- Level playing field for ancillary services:
  Voltage support
  Balancing and frequency support

RES enhancing system not a burden

- **Controllability** of active /reactive power to address congestions and participate in **ancillary services**
- Maintain **system robustness**: FRT capabilities, fault-current support
- Decentralized emergency and restauration functions (islanding, black start…)

Microgrids leveraging cost-efficient integration of RES





Potential both in Europe and Africa

System benefits

Network **resilience and security** of supply for strategic infrastructures (hospital, communications..)

Local voltage and frequency stability support for **weak networks**

Financial benefits

Savings on grid developement to cope with **increasing demand**;

Accomodation of **higher RES** penetration rates closer to demand.

System transformation

The first challenge of African utilities is to deploy electricity infrastructures but the biggest and real one will be to keep these infrastructures running for decades on their own

Challenge #1

Commission numerous infrastructures over a **short** period of time

Challenge #2

Operate, maintain and renew numerous infrastructures over a **long** period of time

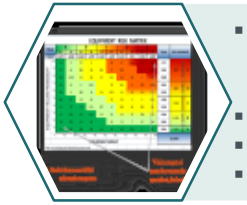
Best practices to improve their performances in each key area of AM

- **Proactive maintenance**
- Life cycle modeling, costing & reporting
- OPEX vs CAPEX decision

OPEX optimisation

- Disposal strategies
- Life time estimation models & health indexing
- Total cost of ownership
- **Risk-based capital investment plan**

REPEX optimisation



- Risk-based decision making embedded in all processes
- Risk register
- **Assets criticality ranking**
- Link with corporate risk

Risk management

- Level of service performance indicators
- Stakeholders consultation (suppliers, clients, shareholders, …)
- **Assets performances monitoring & benchmarking**

Grid performance

- Reliability monitoring
- **Failures root causes analysis**
- Performances monitoring & benchmarking
- Technical reviews & audits

Asset performance

- **Active legal monitoring**
- Asset policies, strategies and plans made publicly available
- Regulatory reporting
- Technical standards definition

Legal Compliance

- **Whole life cycle management**
- Competences management
- Technological watch
- Experience feedback and continuous improvement

Sustainability

- Safety, Health, Environment and Quality policies

Social impact

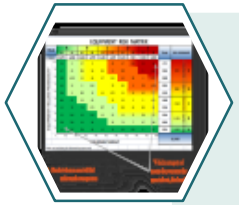
- **PAS 55 or ISO 55000 certification**
- Active in CIGRE and IEC Asset Management working groups
- Stakeholders consultation

Image

… and can demonstrate significant benefits through implementation of asset management

▼15-35%
OPEX[2]

▼5-25%
REPEX[2 4]



▼10-40%
Risk exposure[3]

▼ 50%
System unavailability

▼50%
Failure rate

0 fines
Regulation incentives achieved

▼15-25%
TOTEX[5]

▼60% Safety incidents[1]

>Certification
>International recognition
>Credit ratings
>0 negative press

[1]Lost time injury frequency
[2]While risk exposure steady
[3]While TOTEX steady

[4]Impact on AUGEX can be similar, but much more depending on external factors (regulation rules, accounting, …)

[5]Total Expenditures

Thank you for your attention

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