Distributed Energy Solutions

A catalyst for a successful energy transition of the industry in the Netherlands

CERTIFIED ISO 9001

DNV

OPRA TURBINES

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Commercial Director

- Responsible for sales, marketing and product management at Opra
- Mechanical Engineer (University of Leuven, Belgium, 1995)
- MBA (Vlerick School, Belgium, 1996)
- 25 years in Energy & Finance
- Large company (Siemens) and smaller companies incl startups (Enfinity, 3E, Finesco, Opra)
- Combined cycles, gas & steam turbines, renewables, energy efficiency
- Engineer & entrepreneurial manager

1965-1987 Track record from Norway

1991 Establishment in The Netherlands

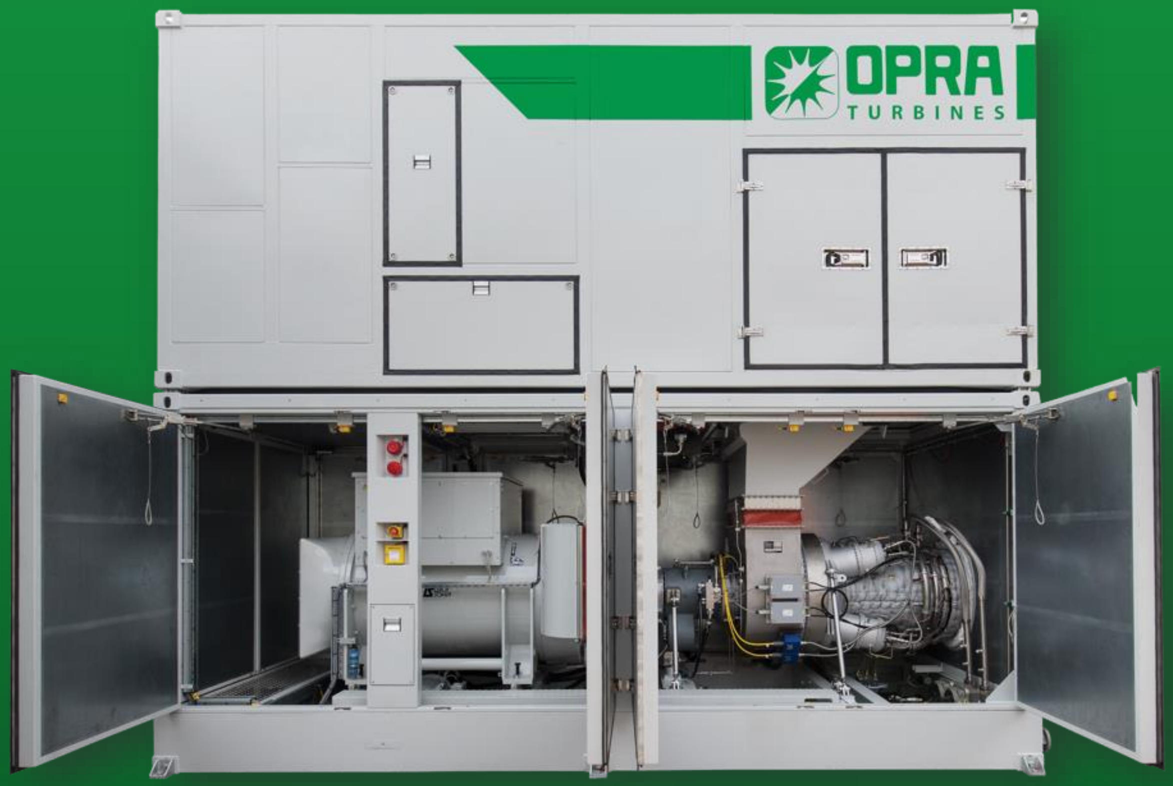
2003 Technology development & demonstration

2005 Commercialization

2016 Extension New facility

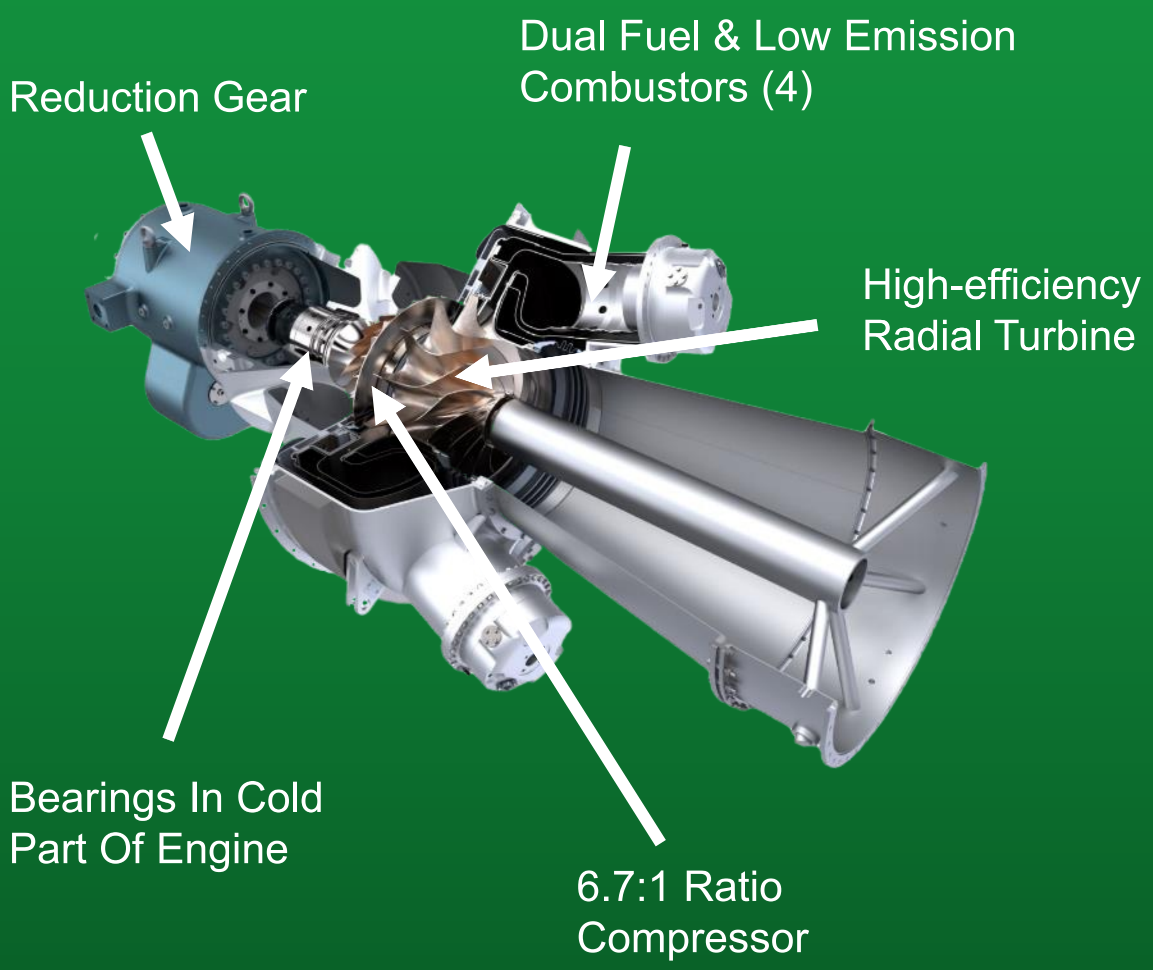
2022 Globalization AIREM Group

OPRA provides containerized gen-sets based on the OP16 gas turbine



- 20 ft integrated standard package
- Mobile – easy transportation
- Quick installation and commissioning
- Ability to handle extreme ambient conditions
- Low foundation requirements
- Fully tested string before dispatch

The OP16 gas turbine



The 1.8 MW OP16 gas turbine engine combines the best of simplicity and high performance

OP16 Gas Turbine	
Electric Efficiency	25%
Exhaust Flow	8.7 Kg/s
Exhaust Gas Temp.	570 ºC
Rotor Speed	26,000 rpm
CHP efficiency	90%
Time between overhauls	42,500 hours

Distributed energy solutions – definition

Visualization Siemens

Distributed energy solutions are electric generation units (typically in the range of 3 kW to 50 MW) located within the electric distribution system at or near the end user. They can be grid connected or stand-alone units.

Examples: small gas turbines, gas engines, fuel cells, photovoltaics, wind power, batteries, flywheels… including also demand-side measures

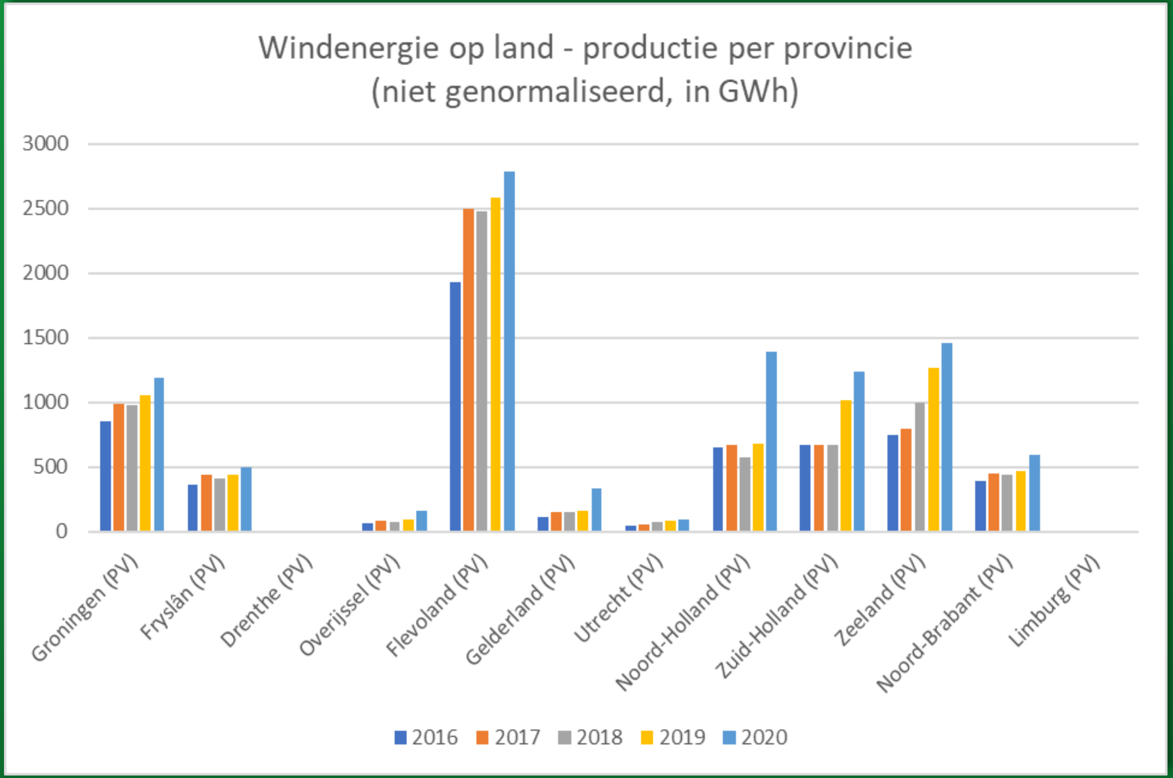
Where permitted by regulation power can be sold back to the grid.

Renewables are by their nature mostly distributed.

Focus of this presentation: small gas turbines

Recent trends and consequences

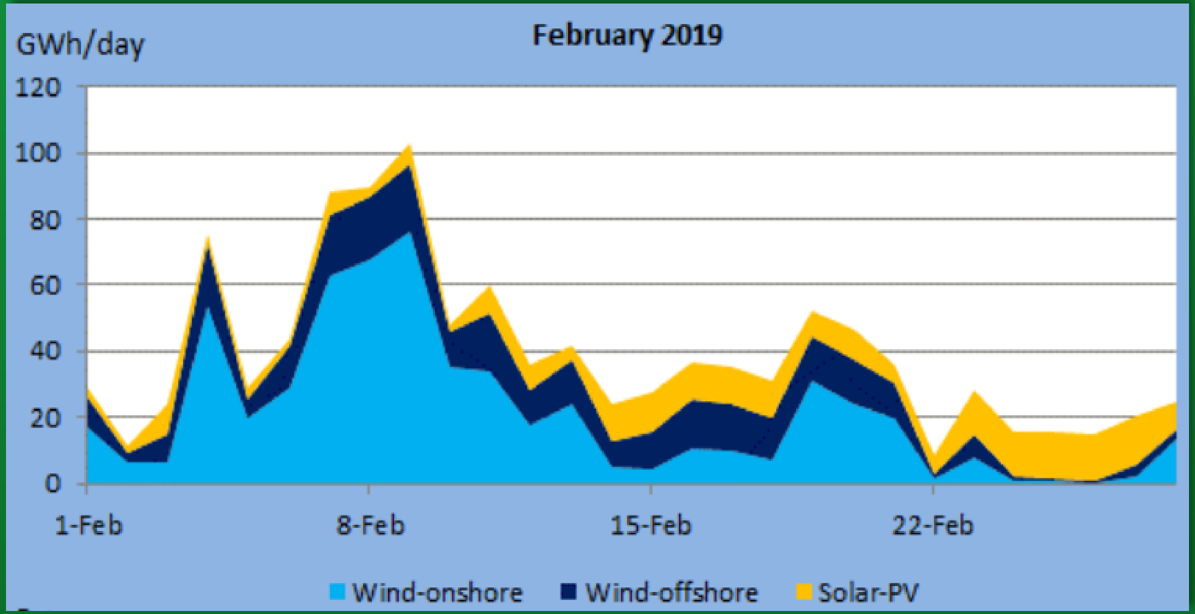
Recent trends and consequences



The increase of solar and wind generation:

- The Dutch Cabinet's target for 2030 is to reduce greenhouse gas emissions by 49%, compared to 1990 levels
- In 2020, renewables accounted for 11,1% in the Dutch energy mix
- The target is to reach at least 25% by 2030
- Geographical spread!

Recent trends and consequences

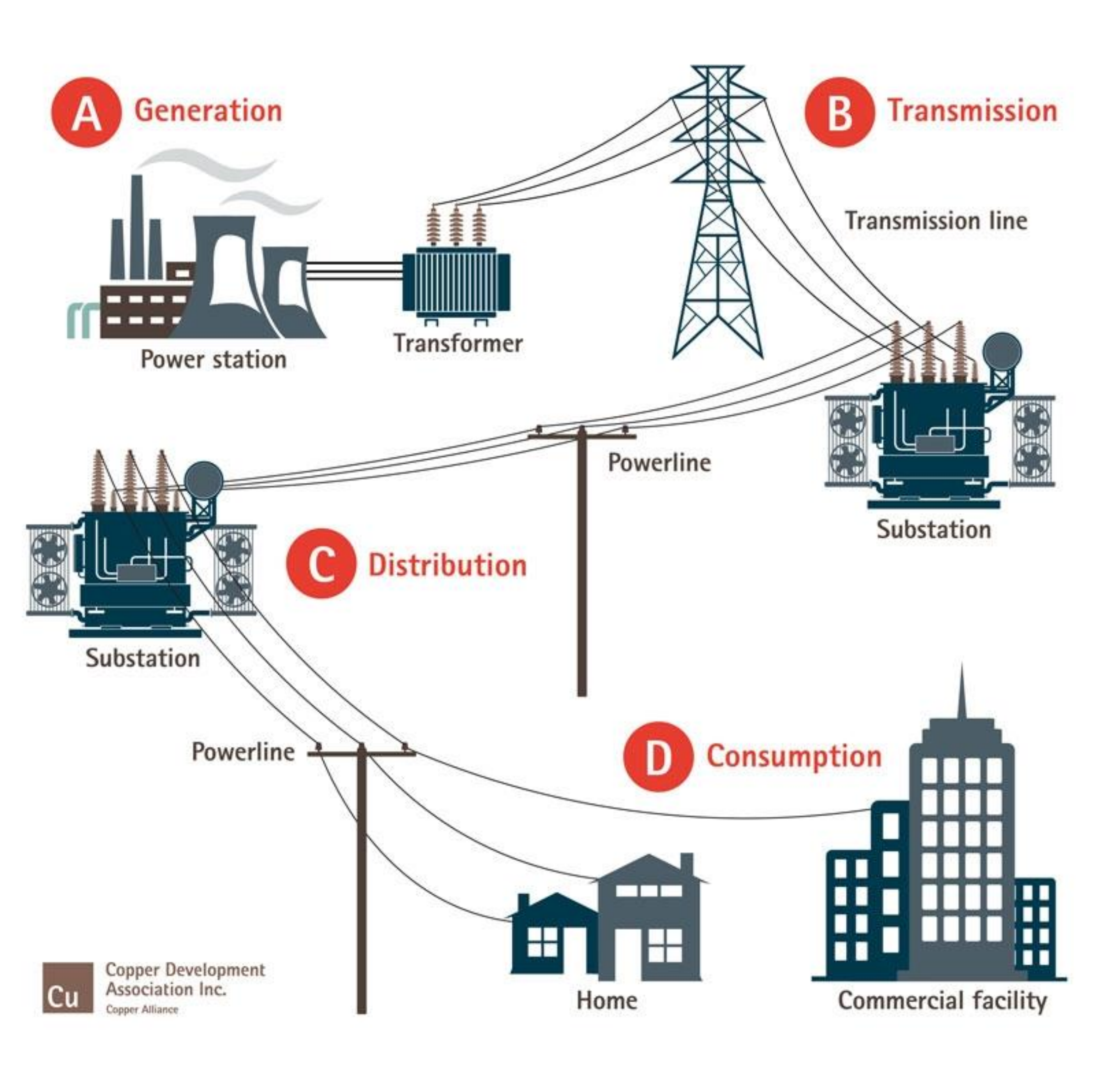


Renewables intermittency:

A growing share of electricity produced by weather-dependent and variable renewables requires increased flexibility to ensure consistent supply to meet demand.

Renewables intermittency means need for stable, quick and sustainable back-up solutions

Recent trends and consequences



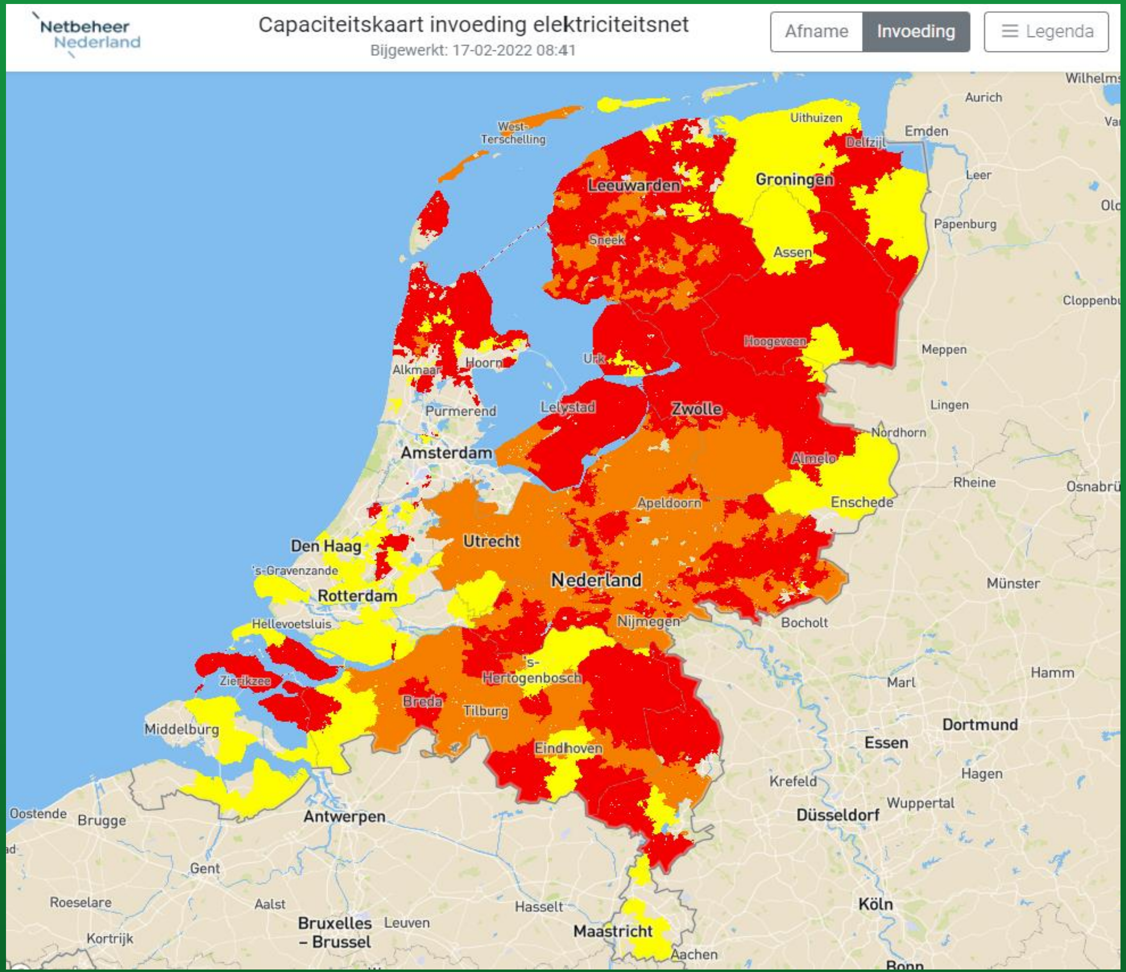
Most grids are decades old and built for:

- large and centralized generators connected to transmission grids
- consumption in only one direction.
- stable and predictable power demand
- price predictability

The primary risks for grid operators were large generators and network failures.

There was limited incentive to understand consumer demand patterns, so power lines were only reinforced enough to accommodate a one way peak load.

Recent trends and consequences



With the increase of renewables, the old model is obsolete:

There is a multiplication of small producers with unstable and unpredictable generation.

The grid in the Netherlands is congested, both for “injection” and “off-take”.

It is becoming challenging to connect any new “producer” to the grid.

To face this change, without big investment into the grid, the power needs to be produced and consumed locally.

no transport scarcity (yet)

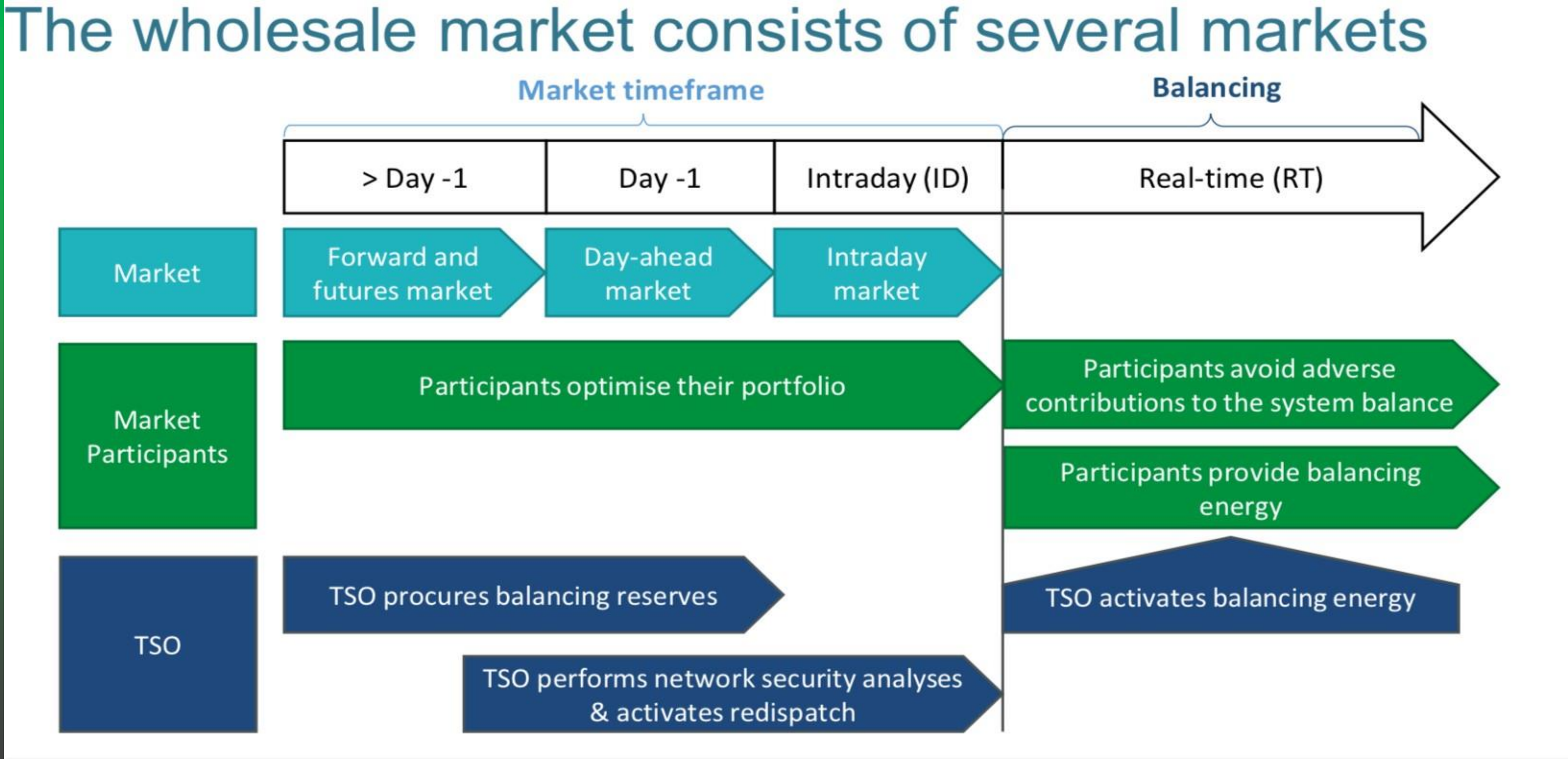
pre-announcement of structural congestion at ACM

there is a threat of transport scarcity, an adjusted quotation regime applies

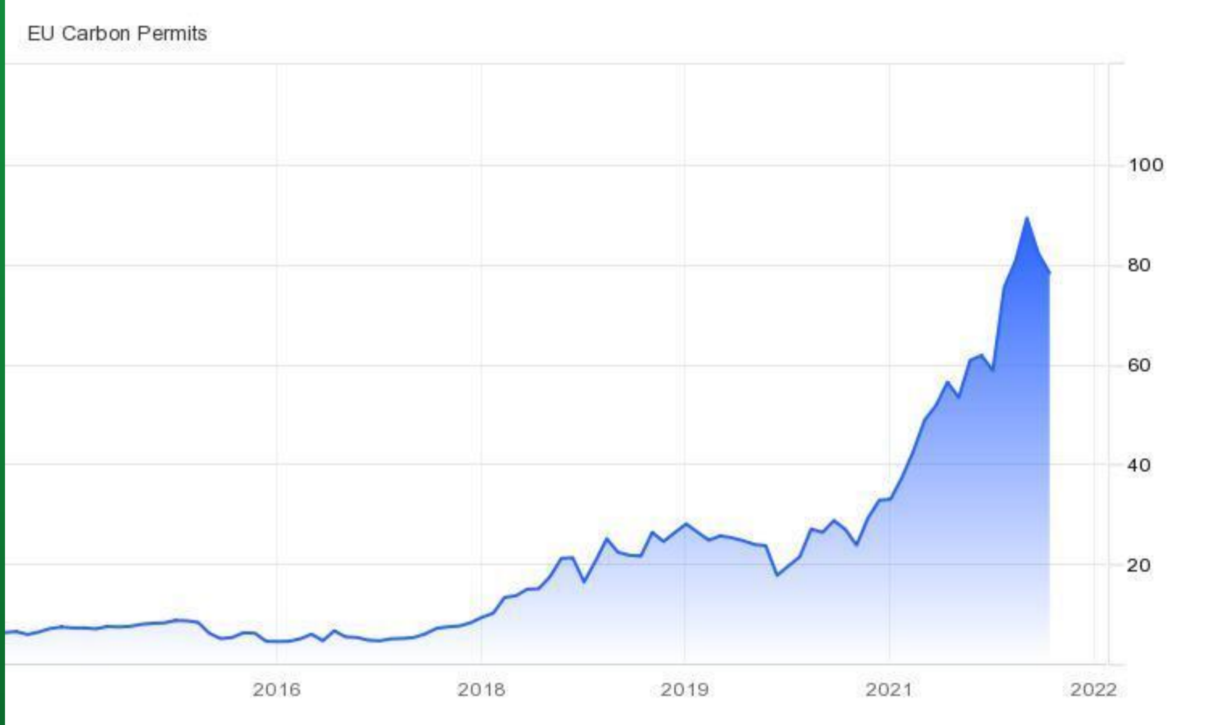
structural congestion, new requests for transport are not honoured

Recent trends and consequences

- Liberalization of the energy market
- Price volatility (renewables, pandemic, conflicts…)
- Valorization of flexibility
    - Day ahead/intraday market
    - Imbalance market
    - Reserve markets
- Importance of clean dispatchable power!



Recent trends and consequences



With the 4th phase of the ETS, the price of CO2 is increasing rapidly:

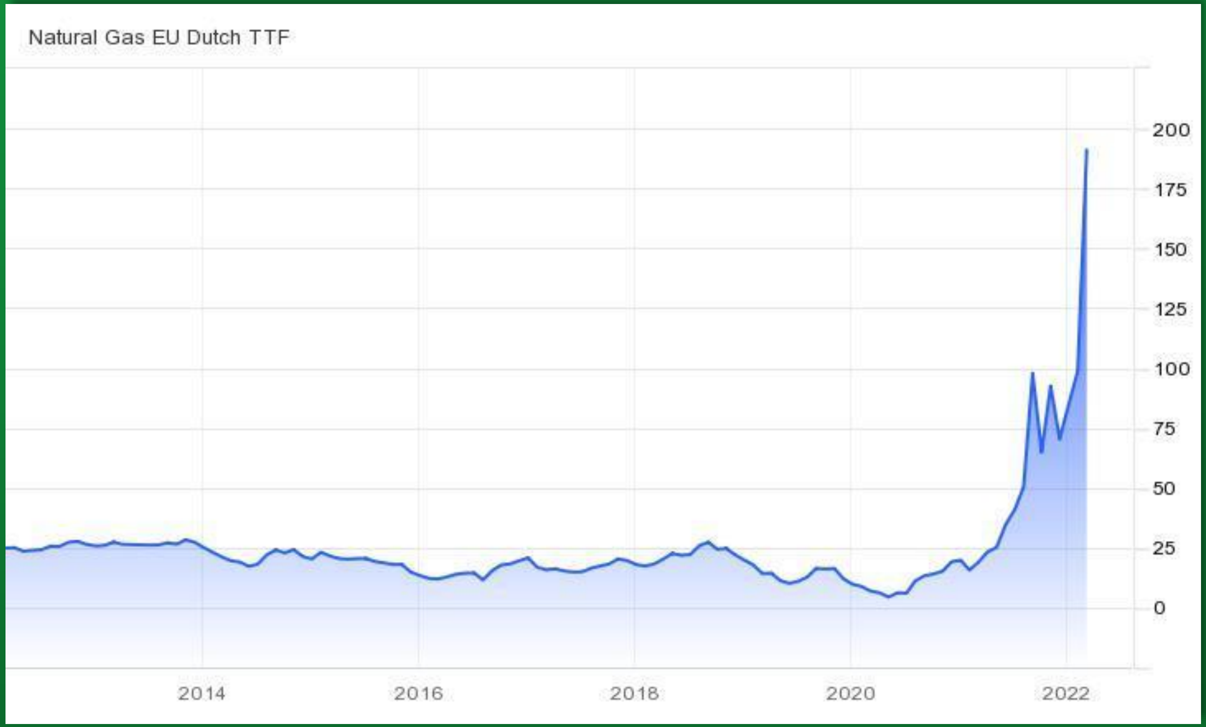
- In 2017, the average price of CO2 was <5 €/ton
- In 2019, the average price of CO2 was 24,9 €/ton
- In February 2022, it reached 96,7 €/ton

This is not temporary!

Many countries (UK, Norway, Netherlands, Germany) have already set higher targets, with CO2 price around **200 €/ton**.

Major opportunity for gas turbines running on zero emission fuels.

Recent trends and consequences



Gas price increasing rapidly:

- Need to optimize utilization of energy
- Need to increase process efficiency (CHP)
- Avoid any flaring or venting in processes
- Use of all possible fuels

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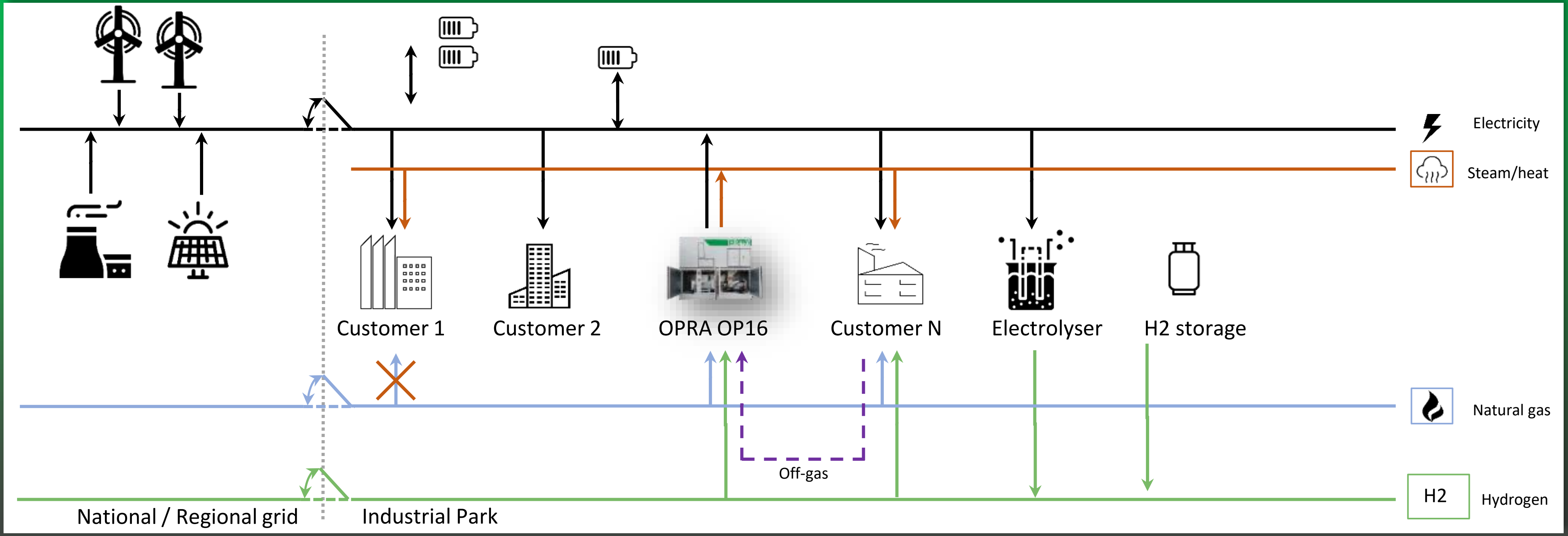
Role of DES in Energy Transition

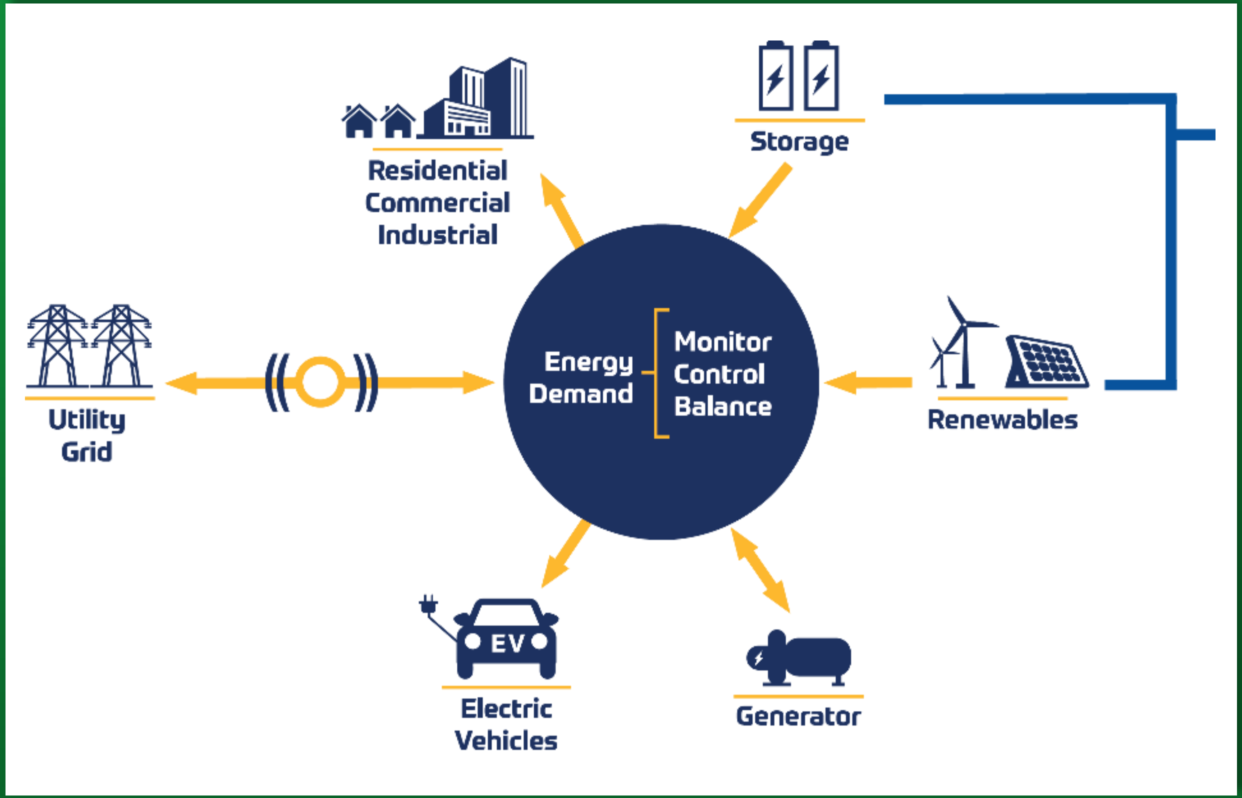
Role of DES in Energy Transition

Integrated resilient smart grids can accommodate:

- the rapid growth of intermittent renewables
- the rise of "prosumers" who both buy and sell electricity into the grid.



Role of DES in Energy Transition



Applications: think local!

Combined heat and power (cogeneration): increases the efficiency of on-site power generation by using the waste heat for existing thermal process

Premium power: reduced frequency variations, voltage transients, surges, dips, or other disruptions

Back-up power: used in the event of an outage, as a back-up to the electric grid

Peak shaving: the use of DES during times when electric use and demand charges are high

Low-cost energy: the use of DES as base load or primary power that is less expensive to produce locally than it is to purchase from the electric utility

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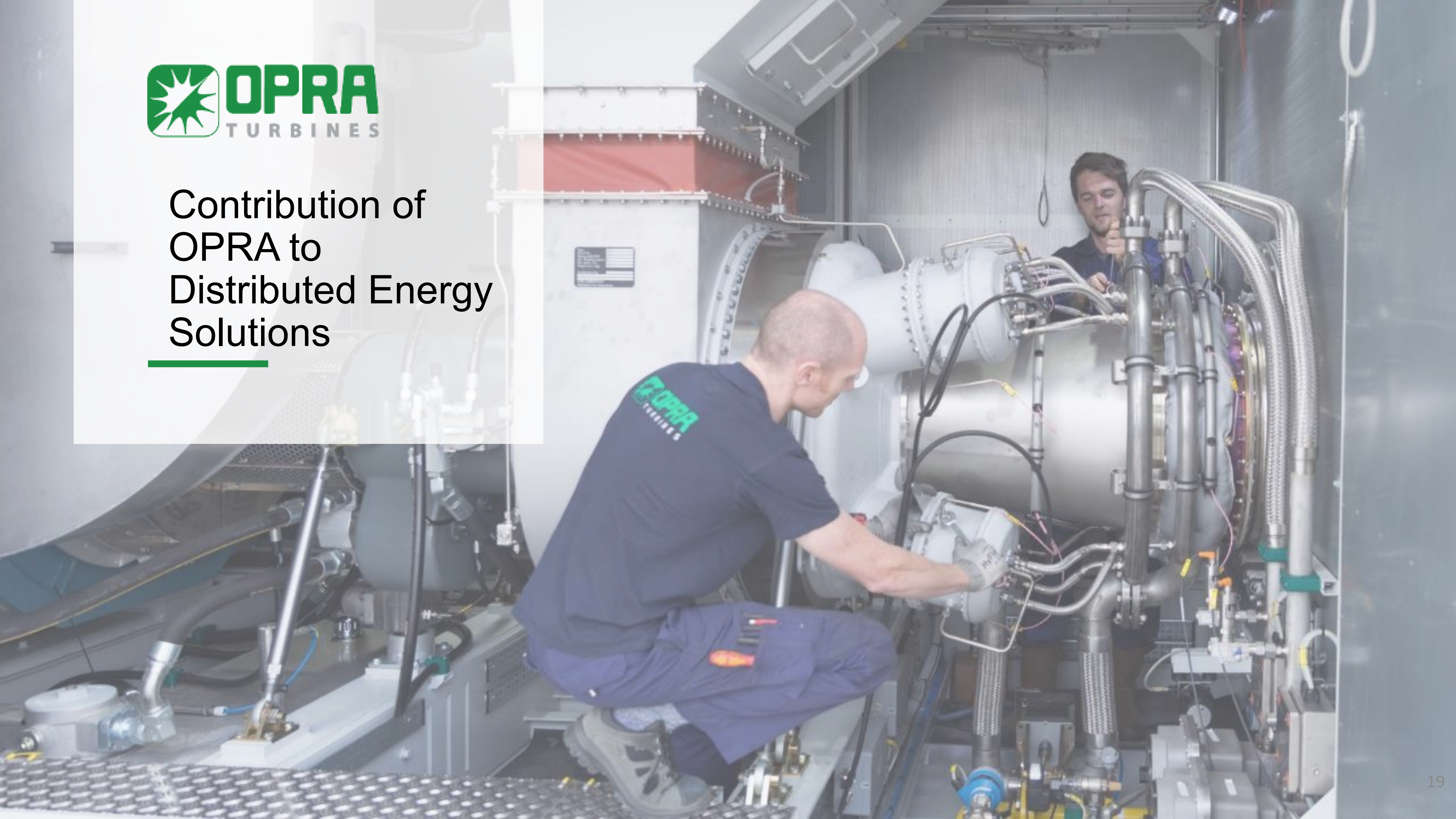
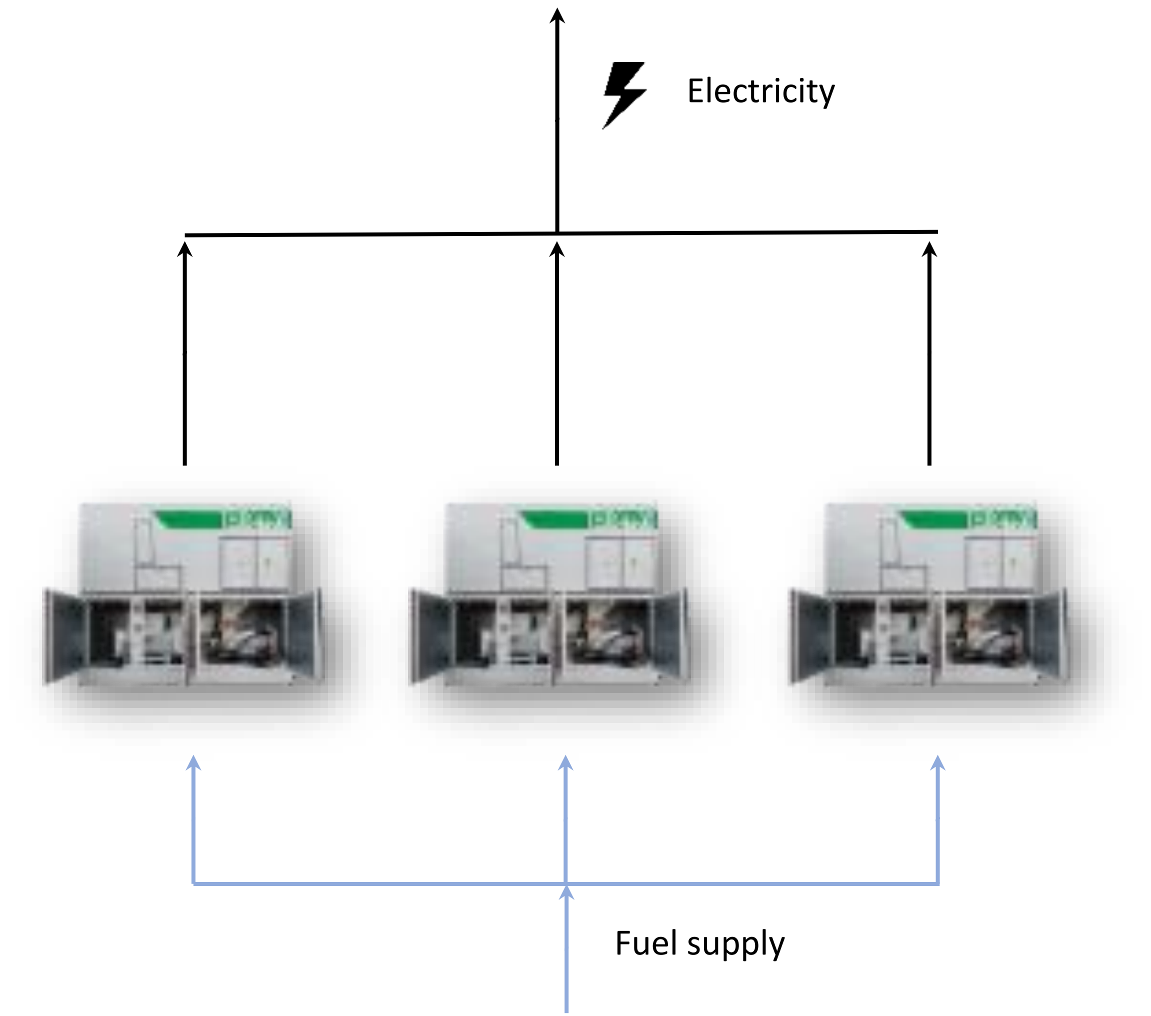
Contribution of OPRA to Distributed Energy Solutions



Contribution of OPRA to DES



Benefits of scalable solutions:

Availability: schedule maintenance sequentially per unit

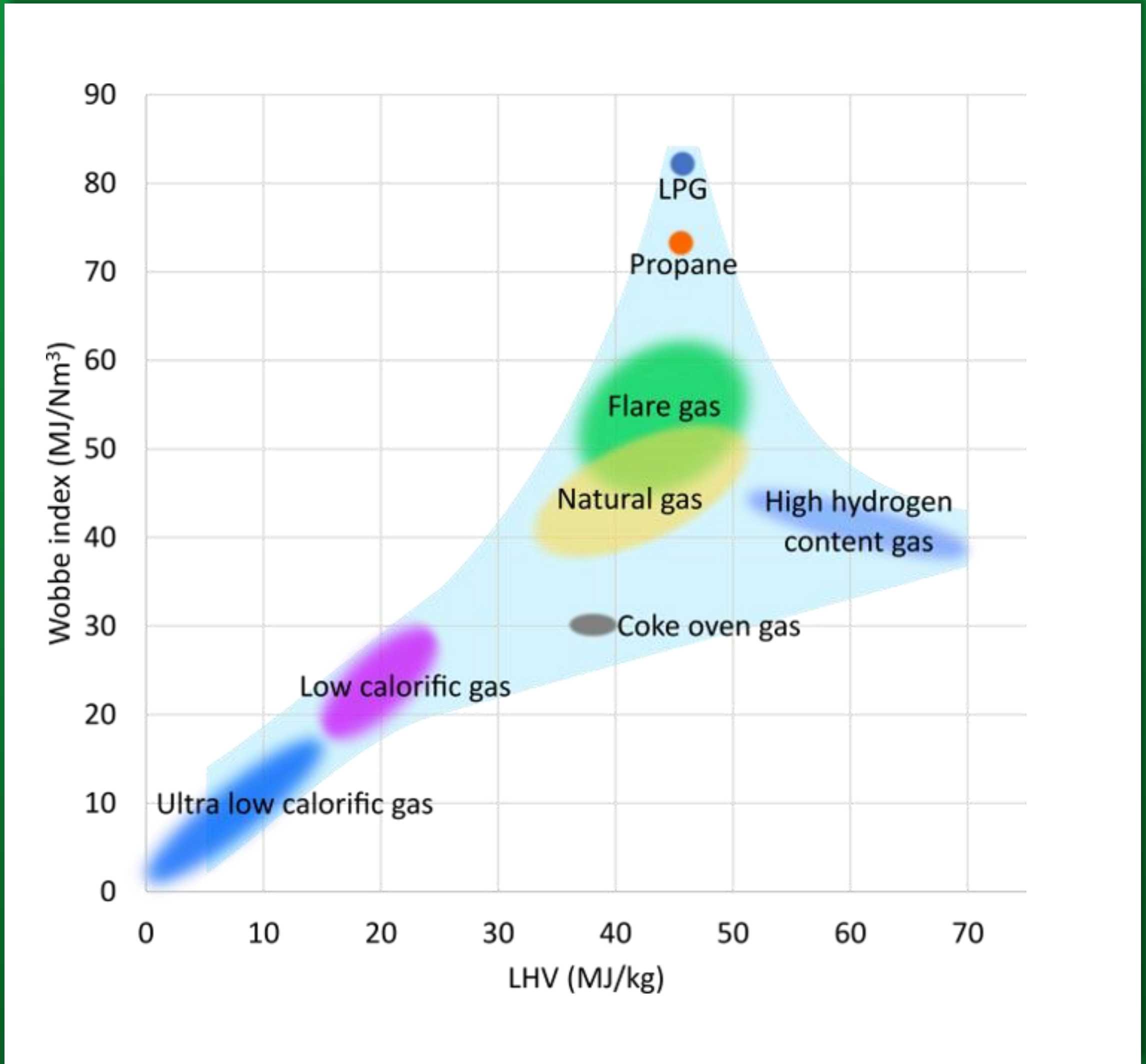
Reliability: minimize common-cause faults
Assume Reliability = 98% for 1 machine
Independent running units:

- Probability that 3 units run out of 3 = 94,12%
- Probability that at least 2 units run out of 3 = **99,88%**

Additional optimizations:

- use 1 unit as 'fore runner'
- have 1 unit with low running hours as 'primary backup'

Contribution of OPRA to DES



Fuel flexibility:

DES opens the opportunity to utilize fuels that are available locally.

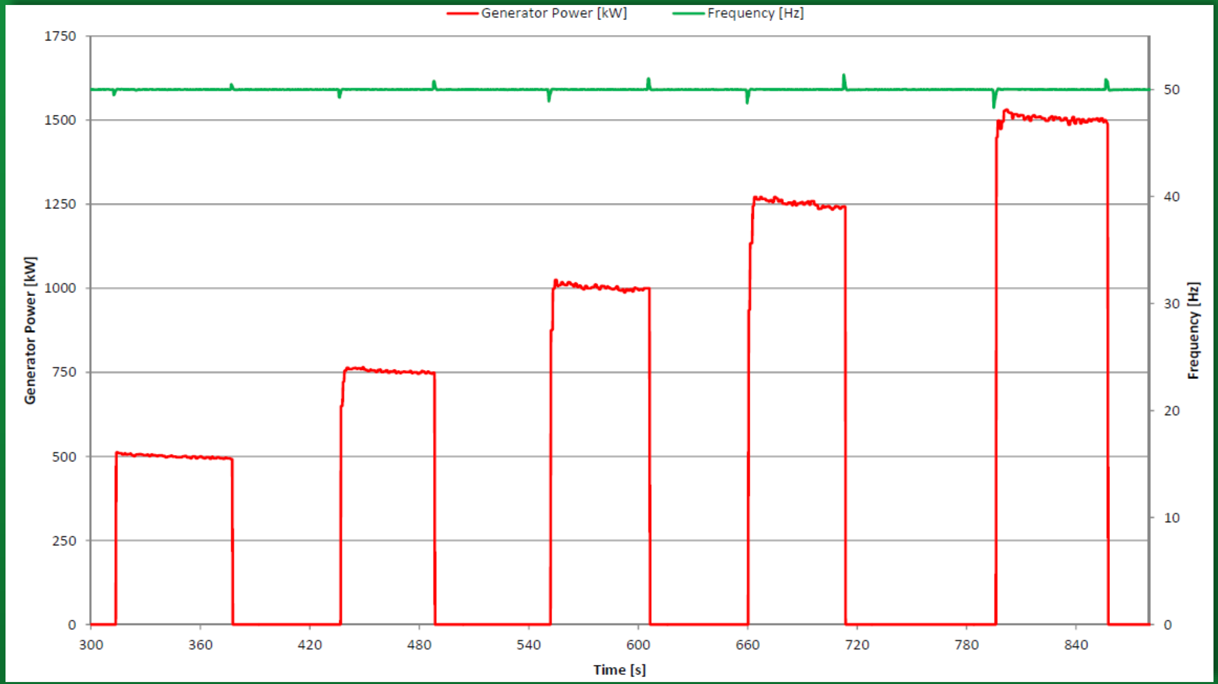
Gas turbines are inherently fuel flexible and the OP16 is particularly optimized to handle almost all possible fuels available, e.g. industrial waste gases.

Dual- and tri-fuel technology enable the use of fuels that are not always available.

Bi-fuel technology enables the use of two fuels simultaneously to handle varying amounts (for example H2 mixed with NG).

Decarbonization is enabled by utlizing fuels such as hydrogen, ammonia and methanol

Contribution of OPRA to DES



Operational flexibility:

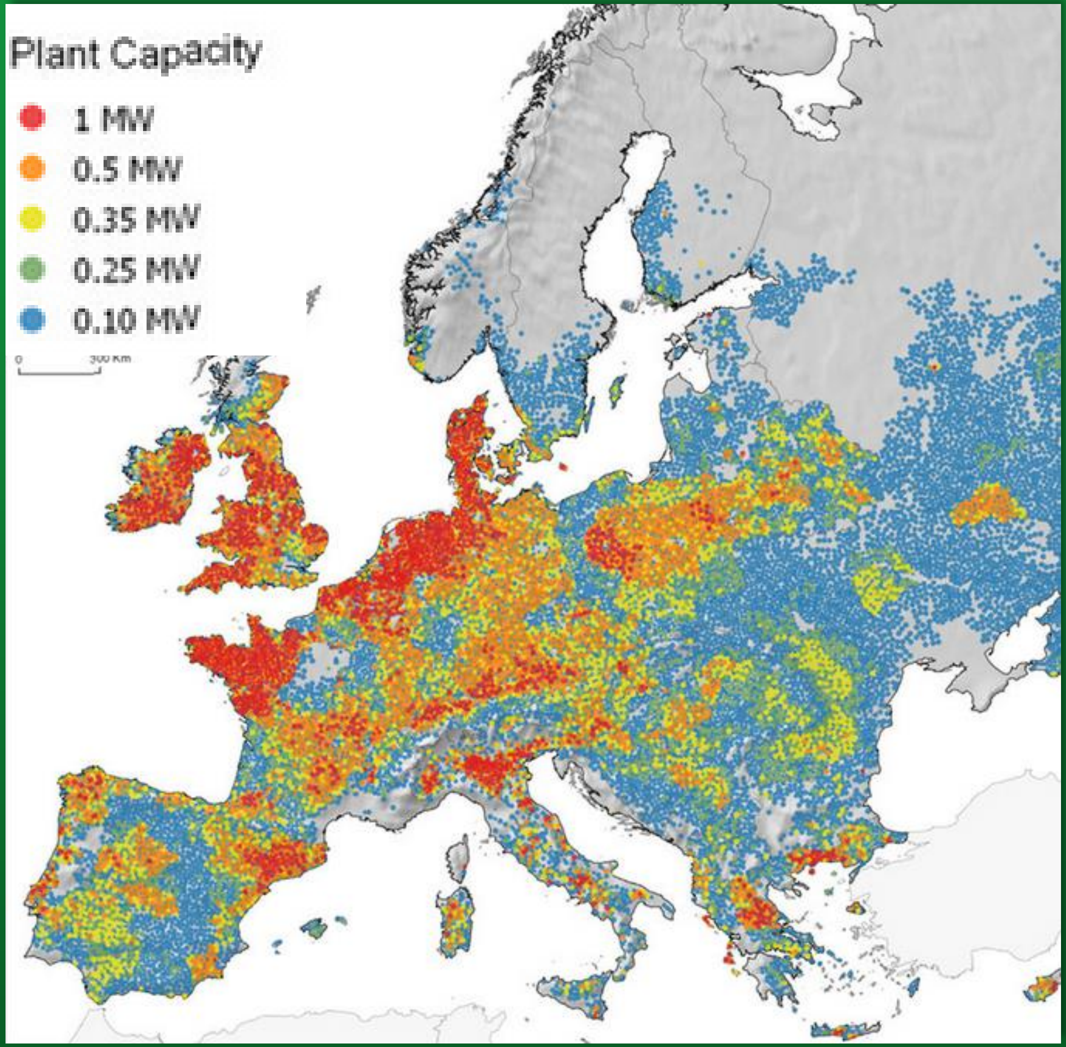
Flexible production of electricity is needed, and will be needed even more in future

The OP16 provides fast start-up and ramping making it suitable to respond to the electricity demands.

Running at part loads and take 100% load steps are perfectly feasible.

This makes it suitable for the Intraday and especially the Imbalance market

Biogas and gas turbines



Suitability map for biogas plant locations
https://www.researchgate.net/publication/327136823_A_spatial_analysis_of_biogas_potential_from_manure_in_Europe

Biogas production in Europe increases year over year:

Even more important regarding energy dependency issue (Russian gas, REPowerEU package)

Biogas production plants are typically small:

- 100 – 2000 kWe
- Reason: uneconomic and unecological to transport biomass over long distances. So no scale up possible.

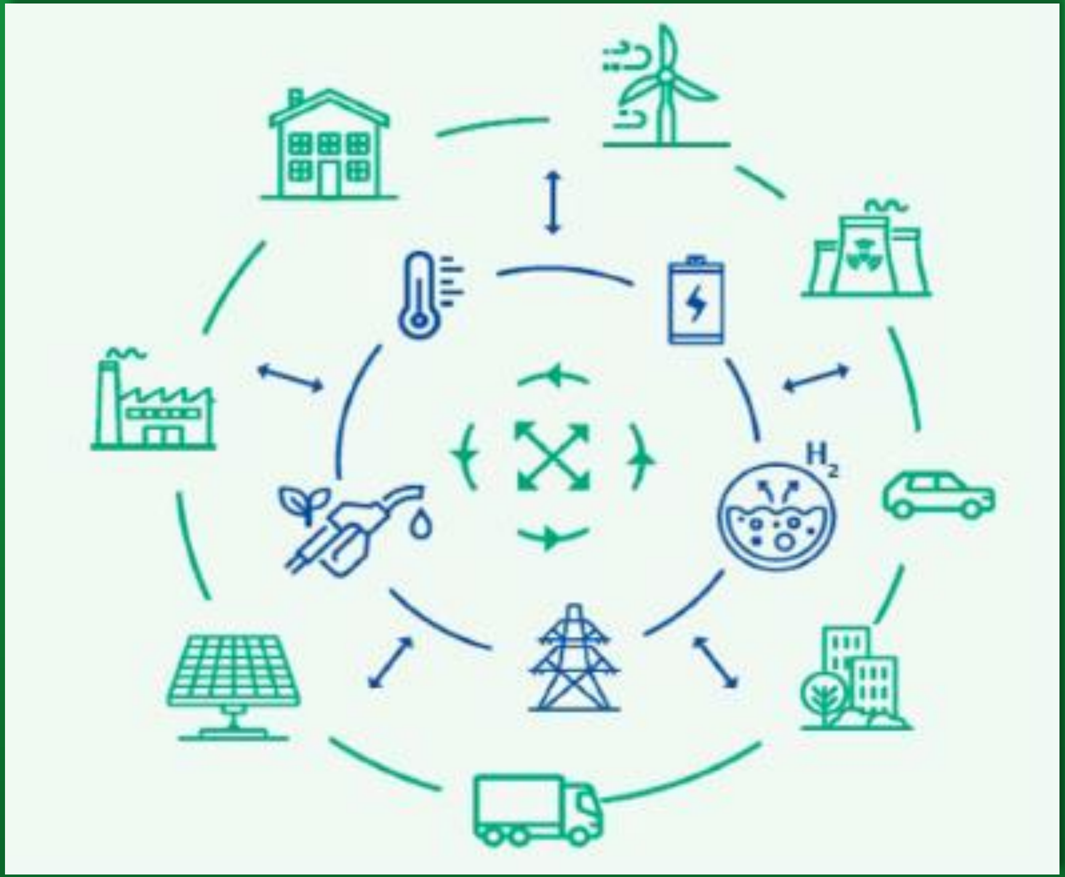
No infrastructure to transport biogas:

- Only for biomethane, which can use the existing gas grid
  - Purification of biogas to biomethane and injection in gas grid requires significant amounts of electricity. If biomethane then used to be burned, it is less efficient than directly burning biogas.
- So biogas to be used on-site
  - Burn directly in gas turbine to produce electricity (for own, local consumption, but also export to the grid)
  - Valorization of heat, as digesting process is temperature sensitive = combined heat and power. Increases overall efficiency of gas turbine.

Biogas quality can vary:

- Contamination with H2S, etc.
- No problem for fuel-flexible gas turbine

OPRA is an innovator and enabler of the energy transition



New opportunities:

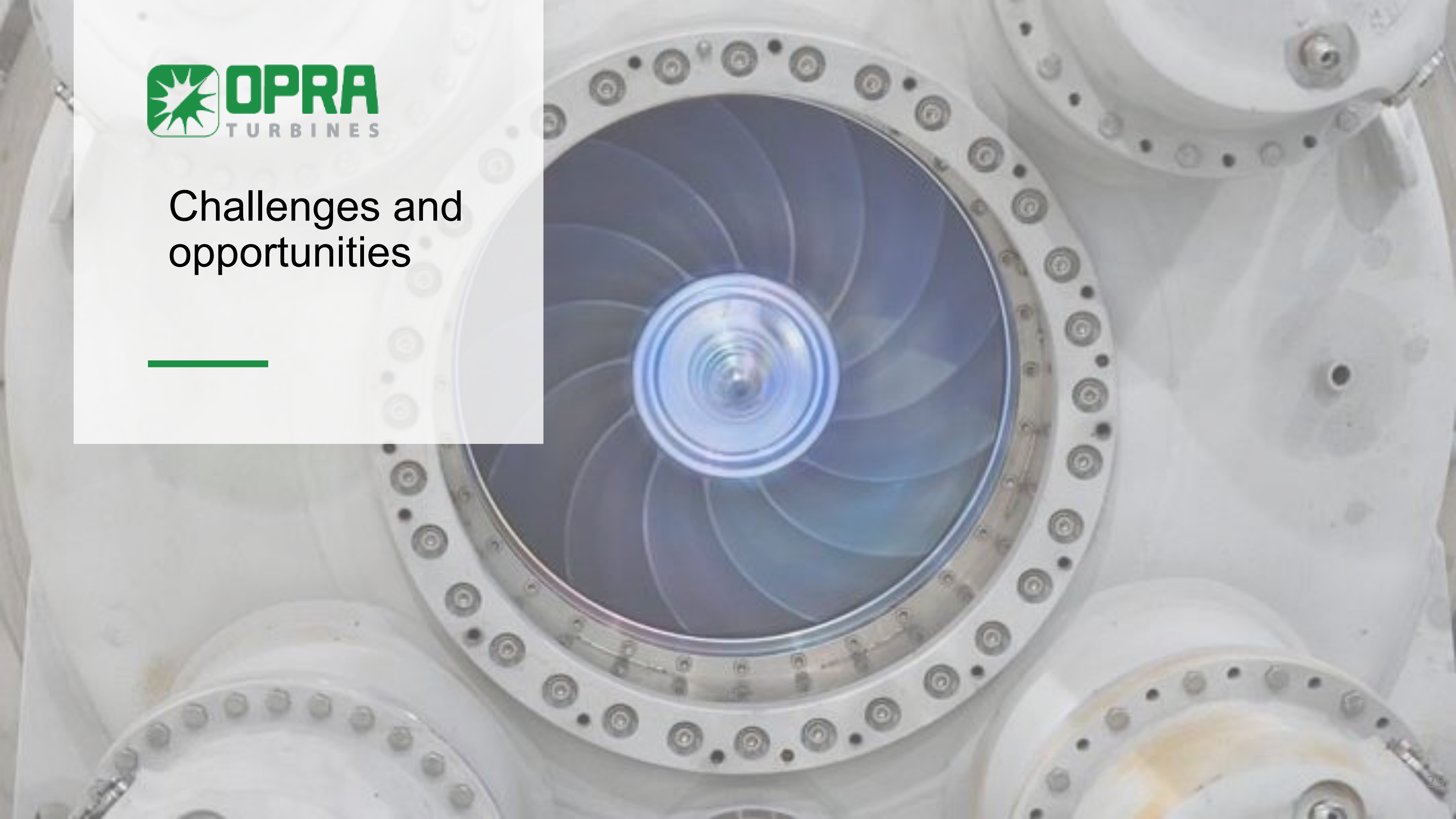
The current trends in the energy landscape provide opportunities and challenges for gas turbines

Small gas turbines with fuel and operational flexibility can play an important role in the energy transition

The small and containerized OP16 gen-set is excellent for demonstrating new technology and innovations

It is also cost a effective way of validating technology before scaling it up to larger heavy duty gas turbine plants making it a technology front runner

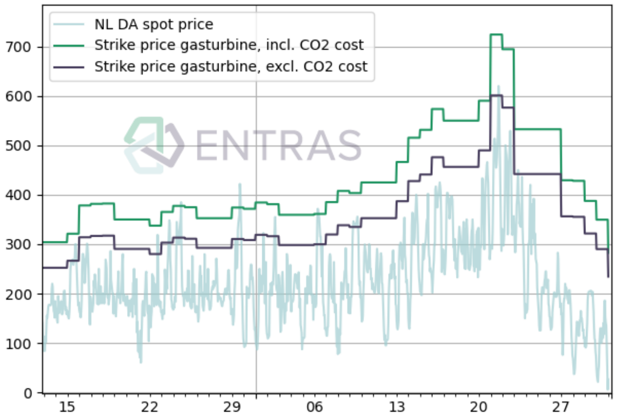
Challenges and opportunities



Opportunities for gas turbines in the energy transition

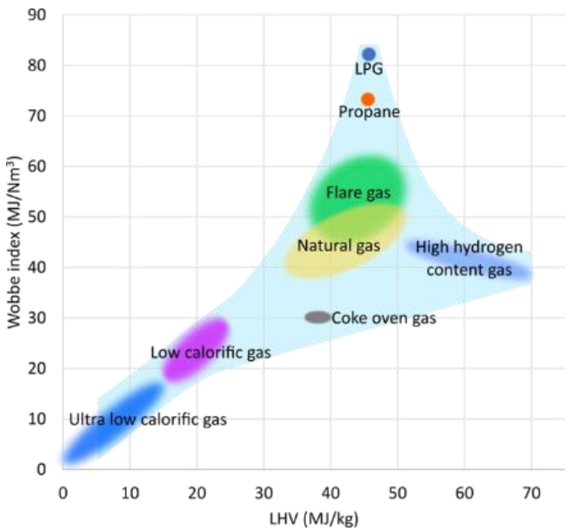
Flexible production

- Fast start-up and ramping of gas turbine
- Limited running hours, if other flexibility will be cheaper; however use of waste fuels reduces cost



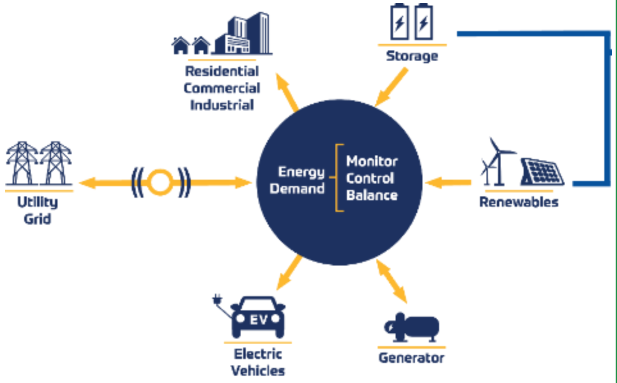
Fuel flexibility

- Gas turbine can take variety of fuels
- Net zero fuels: H2 (and derivatives such as ammonia), biogas, off-gas



Distributed generation

- Lots of small generation is more reliable than large centralised power plant
- Turbines can be located optimally, so that heat can be used as well (cogeneration)
- Electricity generation close to consumption, less electricity to be transported over the grid



Challenges for DGTA

Building synergy:

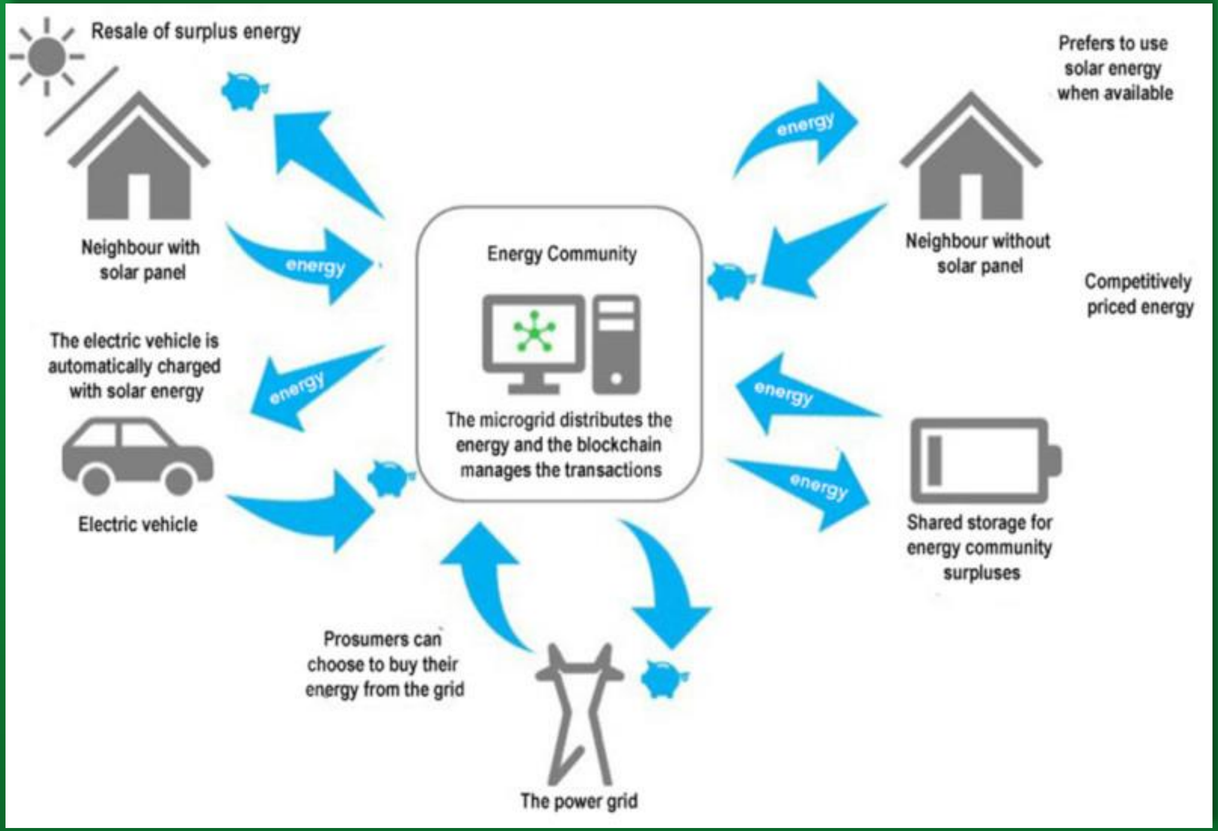
Developing **integrated solutions** at local level.

Integration of:

- Wind and solar production
- Energy storage
- E-fuels local production and storage
- On demand Power generation
- District heating and cooling
- Power management system (monitoring, billing, …)

Propose a shared vision to enable local projects.

Challenges for DGTA



Digitization:

The challenge presented by DES is that they are not controlled by grid operators, which means it is difficult to integrate them into the overall operation of the grid.

Smart digital solutions can help address this challenge, by:

- enabling DES owners to monitor and manage their resources in real-time,
- helping grid operators to monitor more closely and influence DES operations, boosting the value of DES to the grid as a whole.

Digitization is especially powerful as it can be scaled to any aggregated level, from individual devices to buildings, communities, or even a larger region.

ANY QUESTIONS?