

Security of Energy Supply

Setting the scene: The different aspects of security of supply

*9^e Forum Européen de l'Énergie
Conseil mondial de l'énergie – France*

Paris, October 06, 2022

William D'haeseleer



Security of Energy Supply

- Concept often misused/abused by authorities, market actors, consumers; ...
- SoES has several 'dimensions'

Security of Energy Supply

Setting the Scene ***Historic ‘anecdotal’ examples***

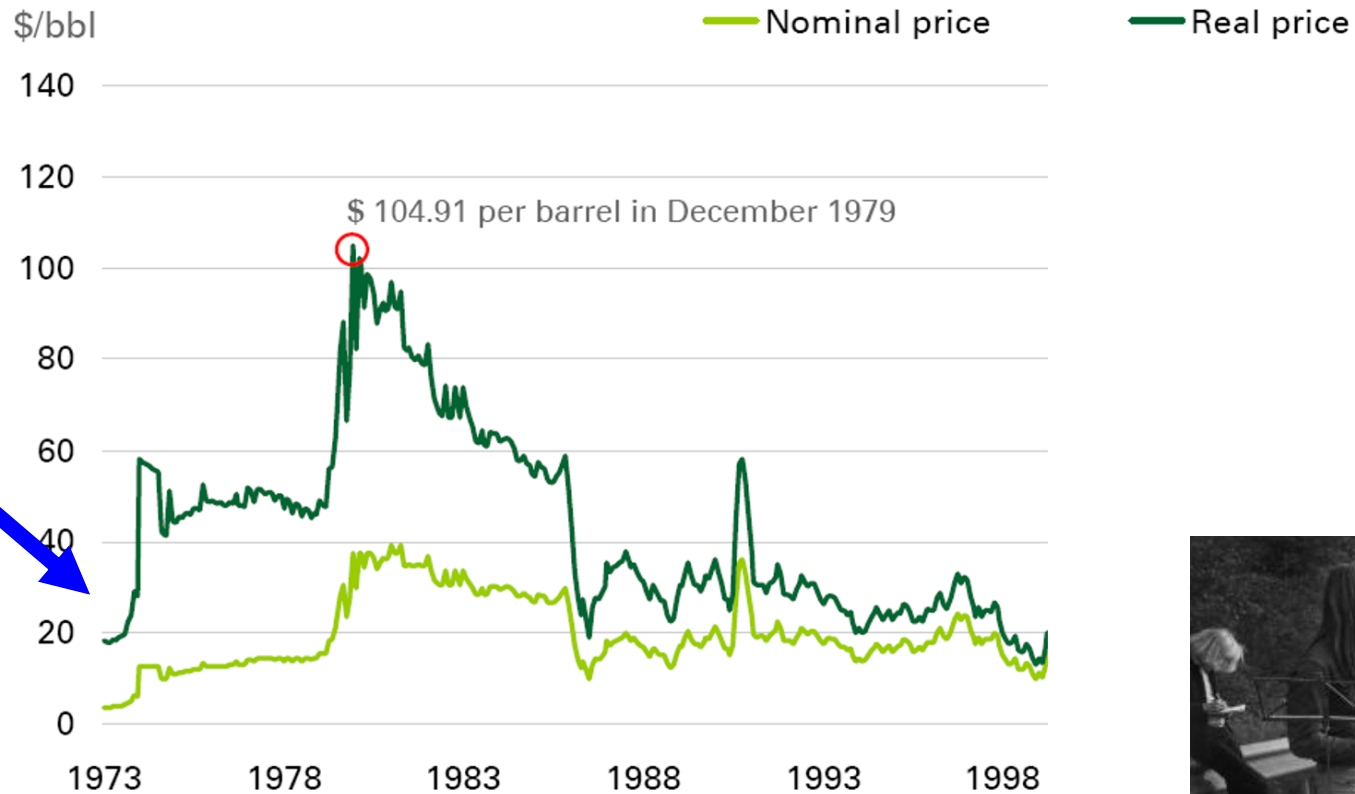
Security of Energy Supply – Petroleum

1973 – Middle East – Yom Kippur War – Oil Crisis – Embargo Western Countries



Security of Energy Supply – Petroleum

1973 – Oil Crisis



BP Statistical Review of World Energy 2008

Car-free Sundays...



Security of Energy Supply – Domestic Coal



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UK miners' strike (1984–85)

From Wikipedia, the free encyclopedia

The **miners' strike of 1984–1985** was a major [industrial action](#) within the British [coal industry](#) in an attempt to prevent [colliery](#) closures. It was led by [Arthur Scargill](#) of the [National Union of Mineworkers](#) (NUM) against the [National Coal Board](#) (NCB), a government agency. Opposition to the strike was led by the [Conservative](#) government of the [Prime Minister](#), [Margaret Thatcher](#), who wanted to reduce the power of the trade unions.

Having coal mines is no guarantee for SoES!

Security of Energy Supply – Domestic Oil

Why Is Iran Importing Gasoline?

Other oil-rich nations don't have to.

BY LEE TESLIK NOV 02, 2007 • 6:09 PM

Having domestic crude oil is no guarantee for useful petroleum products; questionable SoES!

Why does Iran import gasoline?

Two weeks ago, Iran's parliament approved legislation aimed at controlling the ballooning cost of the country's gasoline imports by getting Iranians to drive less. This may seem odd, given that Iran has the world's third-largest oil reserves and used to give gasoline away for pennies per gallon. Why are they now importing fuel?

The country's aging and inefficient refineries can't meet its swelling demand for gasoline. Iran may be brimming with crude oil, but it can't convert enough of the raw product into refined fuels like diesel, kerosene, or gasoline. International sanctions and political pressure from the United States and other countries have discouraged multinational energy companies from making large-scale investments in Iran's infrastructure. Meanwhile, Iranian domestic energy policy—including heavy subsidies for gasoline—has encouraged waste and increased domestic demand.

Security of Energy Supply – Natural Gas



Ukraine

01.01.06

Security of Energy Supply – Natural Gas

Book published in 2008 ...



Security of Energy Supply – Natural Gas

January 01 2009



Security of Energy Supply – Natural Gas

COUNTRIES AFFECTED BY CRISIS



Russia – Ukraine
conflict Jan 2009

Security of Energy Supply – Natural Gas

Belgium
unaffected



Russia – Ukraine
conflict Jan 2009

Security of Energy Supply – Natural Gas

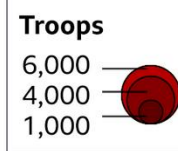
Russia – Ukraine conflict Jan 2009

- A commercial dispute
 - “more market-oriented prices” for former CIS member only
 - “fair transit prices” Russian gas through Ukrainian pipelines
- But clearly also **geo-political** elements

Security of Energy Supply – Natural Gas

Where Russia's troops are positioned

- Newly arrived units
- ▲ Russian units in Belarus exercises
- Permanently stationed units



*Russia annexed Crimea in 2014

Note: Some locations in Belarus are approximate

Source: Rochan Consulting, Maxar, 11 February

BBC

Geopolitics – 2021-2022 Russia-Ukraine-NATO tensions

So-called 'Joint military exercises...'



Feb 24 2022: Full-fledged invasion of Ukraine by RF



EPA/RUSSIAN DEFENCE MINISTRY

Thousands of Russian troops were taking part in joint military exercises in Belarus, which borders Ukraine

Security of Energy Supply – Natural Gas

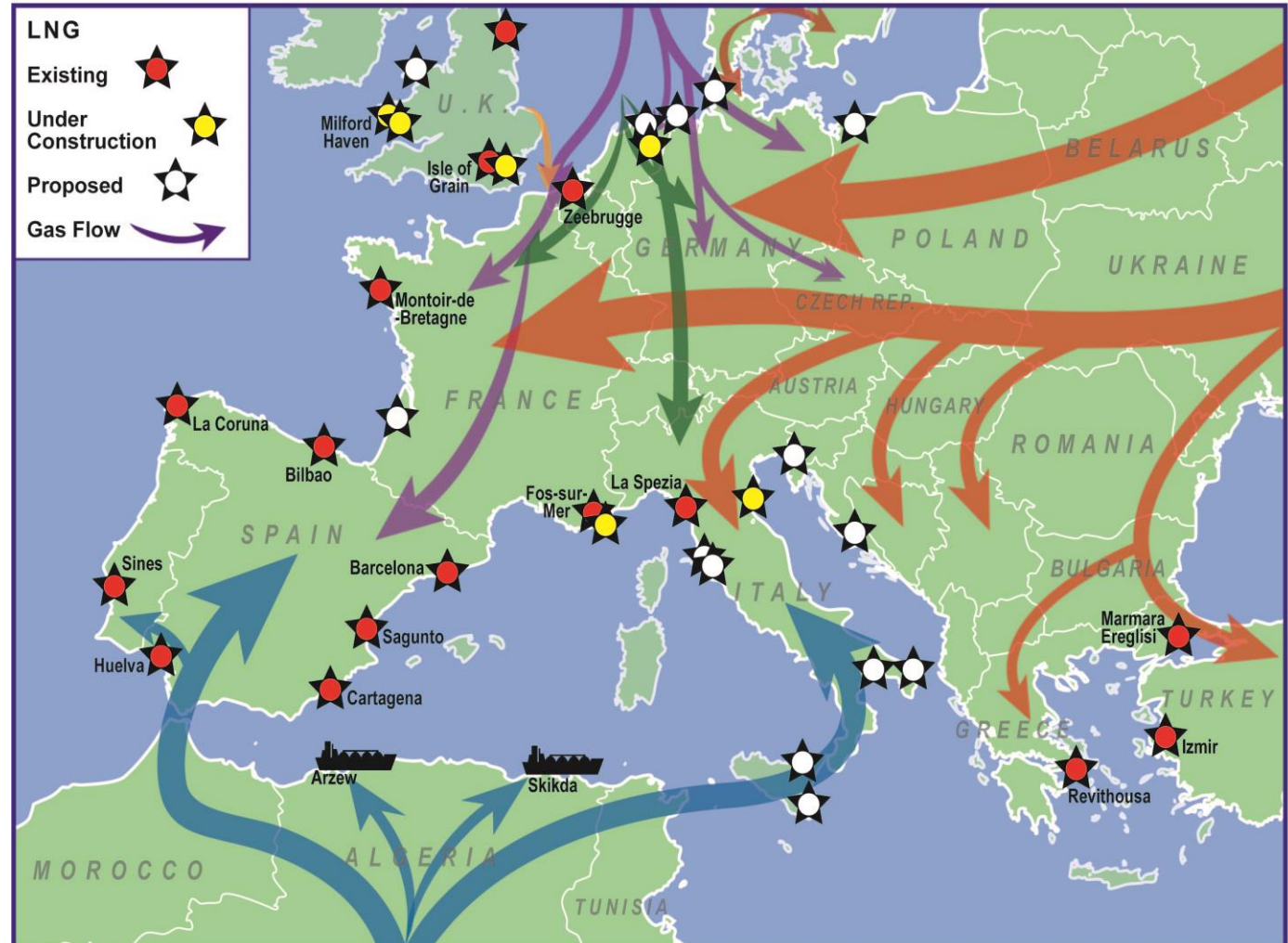
**Avoid
unidirectional
or
unilateral
dependence,**

**whether from Russia
or any other supplier !**

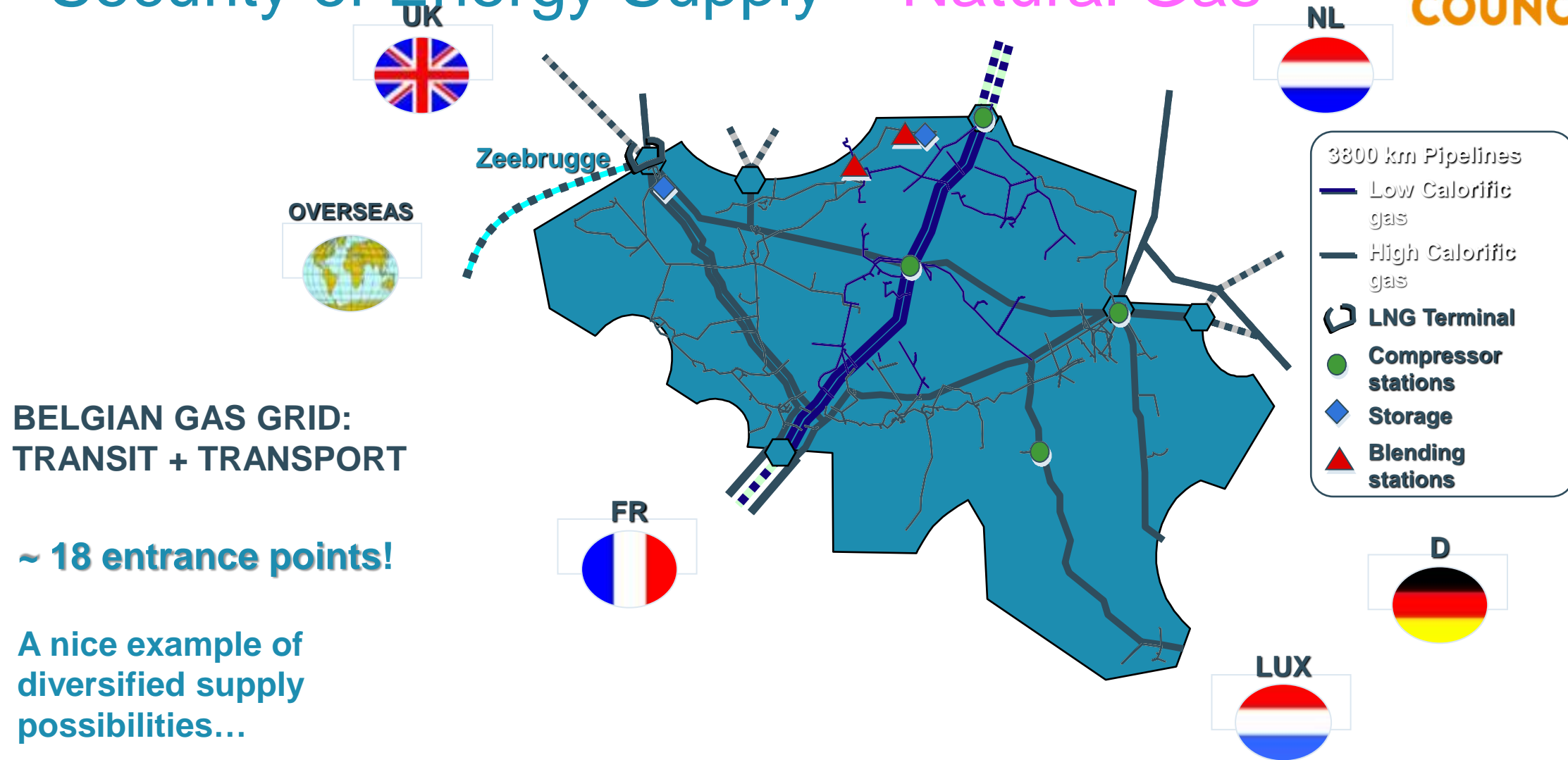


Security of Energy Supply – Natural Gas

Such
multi-polar NG delivery
is
much better!



Security of Energy Supply – Natural Gas



**BELGIAN GAS GRID:
TRANSIT + TRANSPORT**

~ 18 entrance points!

**A nice example of
diversified supply
possibilities...**

Security of Energy Supply – Natural Gas

Germany's 'tunnel' vision...

Avoid reliance on this...



And go for direct connection to Russia



Security of Energy Supply – Natural Gas

Nord Stream 1 opening November 08, 2011

Gerhard Schroeder,
Francois Fillon,
Johannes Teyssen,
Angela Merkel,
Mark Rutte,
Dmitry Medvedev,
Alexey Miller,
Guenther Oettinger,
Kurt Bock,
Erwin Sellering.



<https://www.gazprom.com/f/posts/77/872260/40.jpg>

Security of Energy Supply – Natural Gas

Figure 6.1: Nord Stream 1 and Nord Stream 2 pipelines



Source: OIES

And DE wanted more...

Hence Nordstream 2...

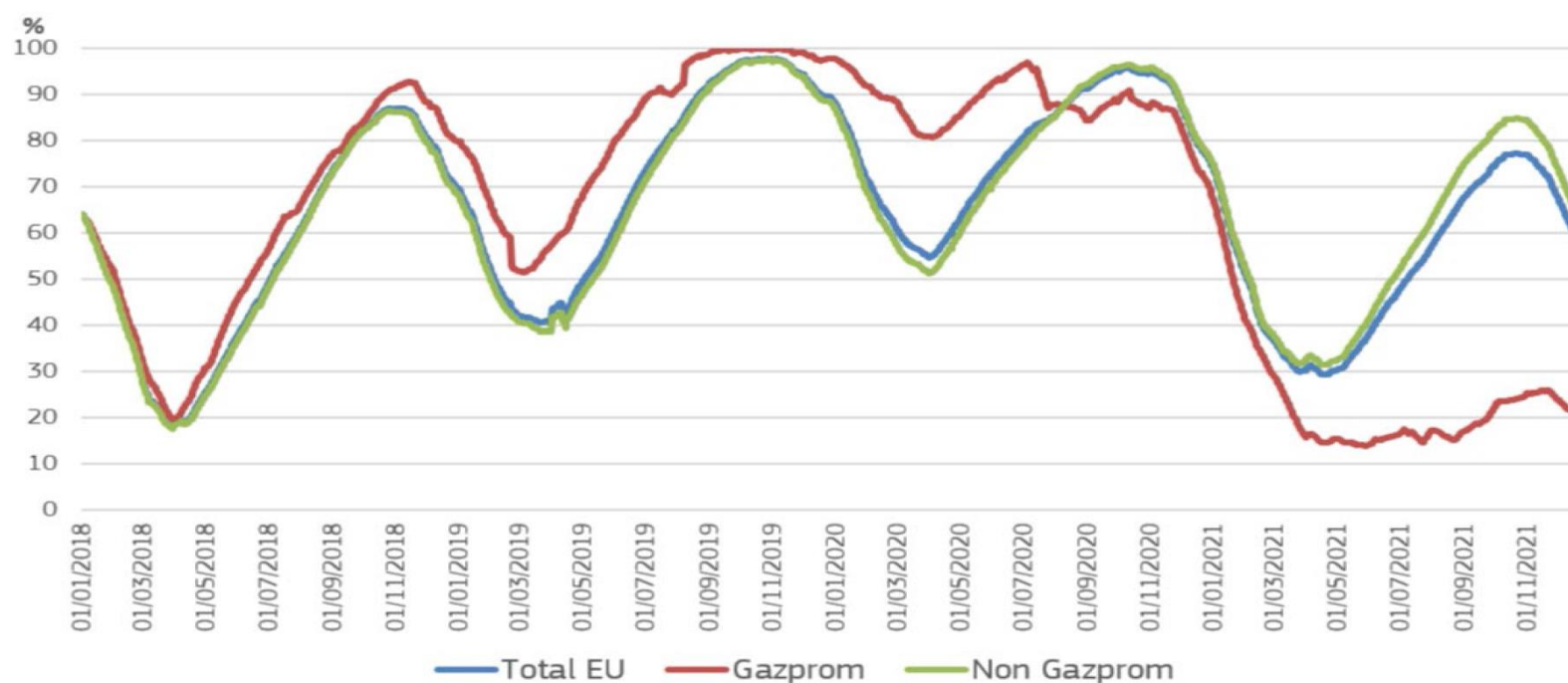


DE needed a war
to realize that
unilateral dependence
is not 'wise'...

**Nordstream 2
halted indefinitely
after Feb 24, 2022**

NG storage in Europe

Figure 20 – Difference in the filling rates of Gazprom controlled storages and other storages



Source: JRC calculations, based on Gas Storage Europe AGSI+ data

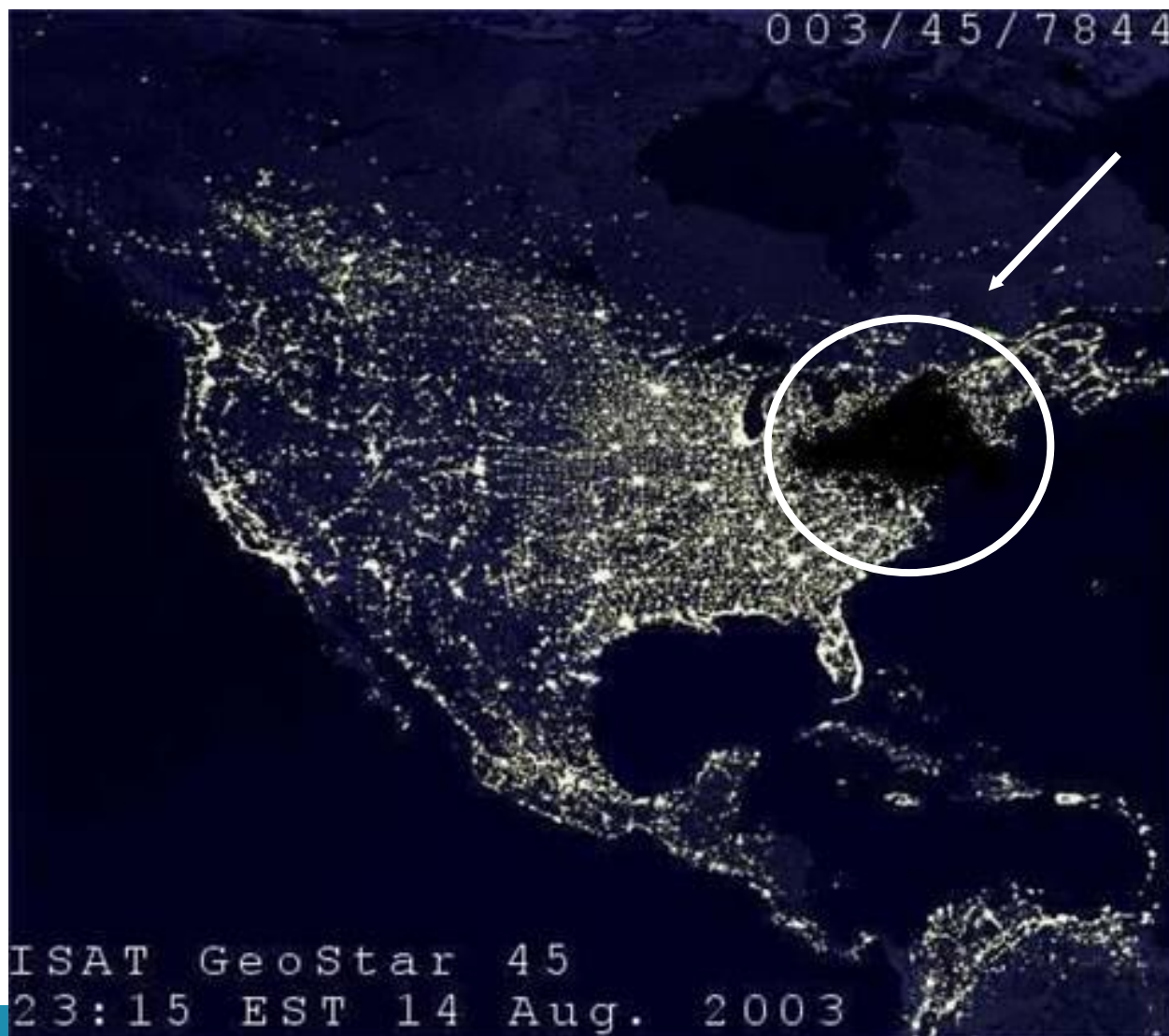


Security of Energy Supply – Electricity



North-East
USA & Canada

Security of Energy Supply – Electricity



North-East
USA & Canada

August 14 2003

Security of Energy Supply – Electricity



NY by night...

Security of Energy Supply – Electricity

Europe did not want to stay behind...



Sept 28 2003



Security of Energy Supply – Electricity

Analysing the Causes of the Italian and Swiss Blackout, 28th September 2003

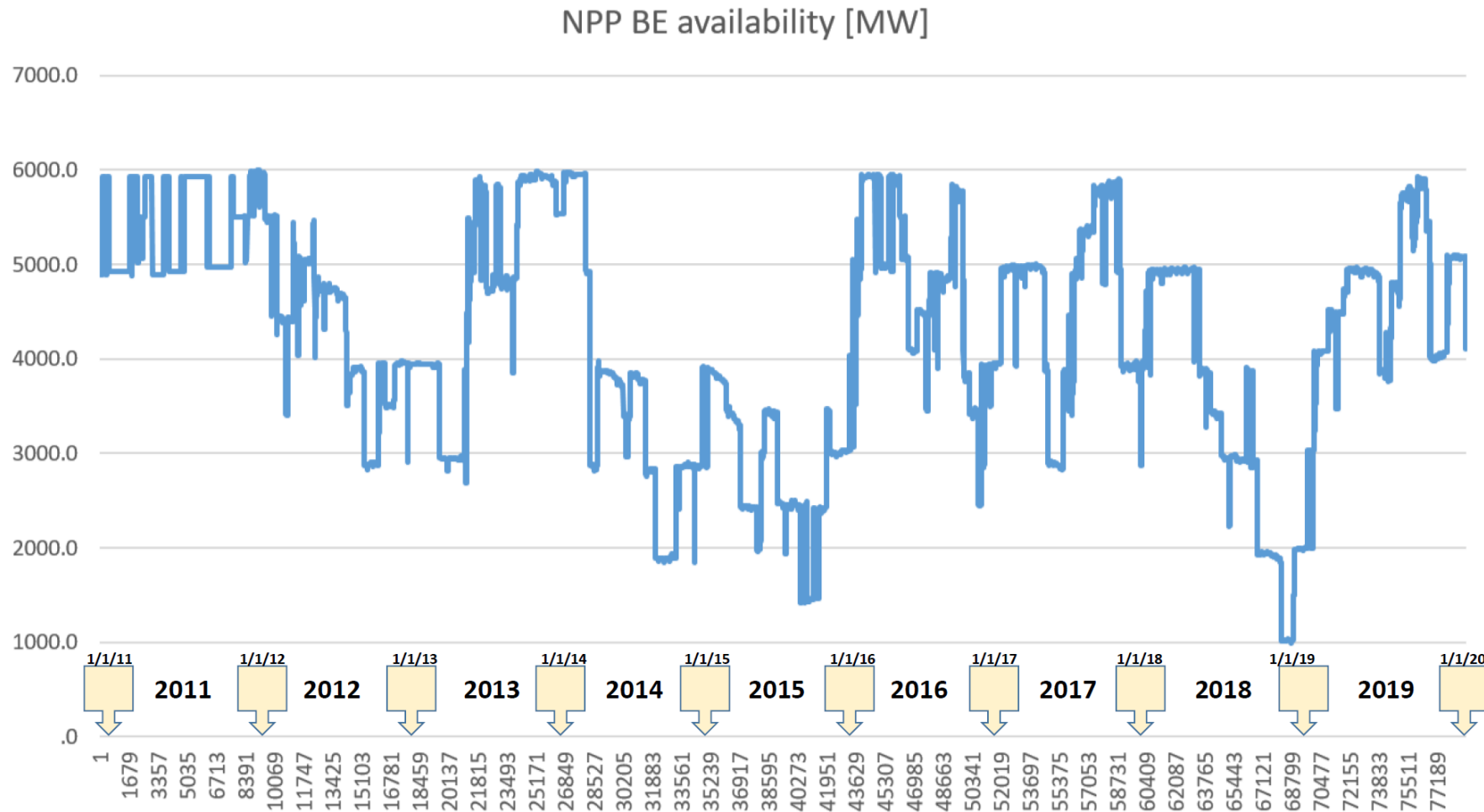
Chris. W. Johnson

Glasgow Accident Analysis Group, Department of Computing Science,
University of Glasgow, Glasgow, G12 8QQ, Scotland, U.K.

Rome by night...



SoS - Availability of Existing Infrastructure (BE)



NPPs are fine for SoES if they are available to run!

SoS - Availability of Existing Infrastructure (FR)

- Now, ~ half of the 56 FR NPPs are halted
- Many plants in annual maintenance & fuel reloading
- But ~12 NPPs down for safety issues: **stress corrosion cracking**
- Output in 2022 lowest in more than 30 y
- FR must import 'heavily' in winter 22-23
- “Grid operator RTE may need to limit power supply to large industrial users”
- “A nightmare scenario would be a dry summer... and a cold spell across EUR.”
- **Availability problems when generic safety concerns in standardized reactor designs**

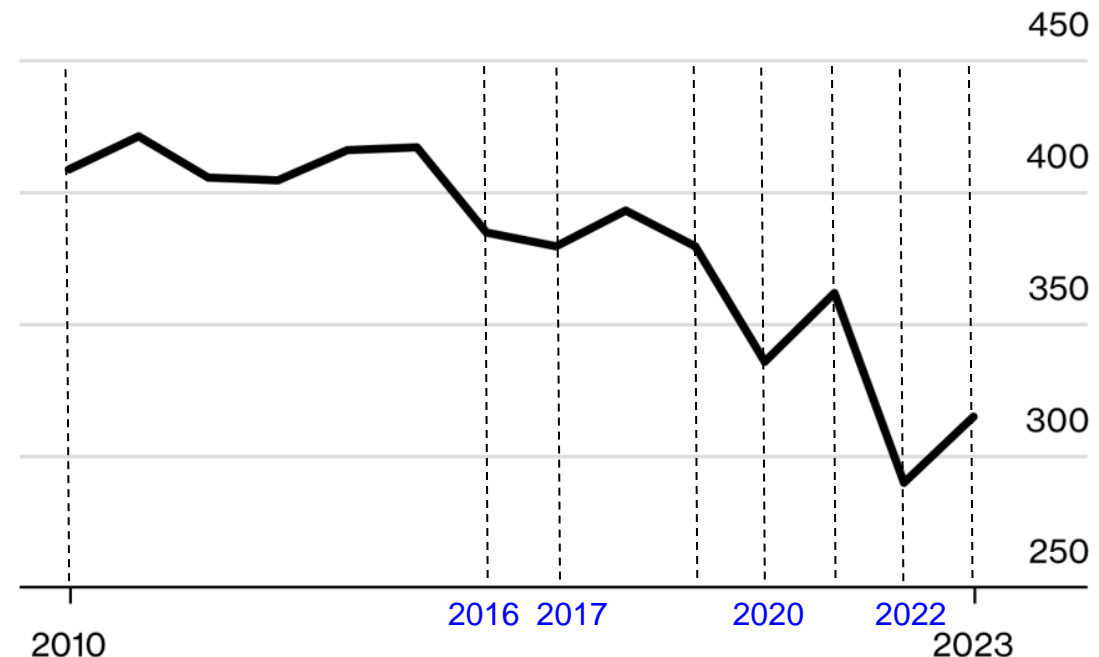
Bloomberg

May 27 08:CEST



French Nuclear Meltdown

EDF's atomic output slumps on heavy maintenance and repair program



Source: Electricite de France SA
Figures for 2022 and 2023 are the mid-range of EDF's forecasts

Structured Analysis

- **Strategic Security of Supply**
- **Adequacy**
- **Sudden Cuts / Black Outs**

Structured Analysis

- **Strategic Security of Supply**
- Adequacy
- Sudden Cuts / Black Outs

SoS – Structured definition

(1) Strategic Security of Supply

= Continued provision of *primary* fuels/sources
to satisfy the request of the end consumer,
given that all means exist to get the energy flux from producer to consumer

This level concentrates on the

‘producer’ side

SoS – Structured definition

(1) Strategic Security of Supply

1. Physical availability of primary energy sources

- enough endowment with natural resources ('stocks')

- * coal, oil, natural gas

- * uranium

for oil, partly the issue of “peak oil”

- enough endowment with natural renewable *flows/streams*

- * elevation & water flow (for hydro power)

- * biomass (fertile land area, forests)

- * meteorological conditions (wind, sunshine)

- * geothermal conditions

SoS – Structured definition

(1) Strategic Security of Supply

1. Physical availability of primary energy sources

../..

2. Sufficient investments in production capacity at production sites

- investments in oil & gas production capacity – also peak oil
- investment in coal & uranium mines
- investment in hydro dams, lakes, ...
- Investment harvesting capacity (wind turbines, solar PV, solar heliostats & receivers for CSP, geothermal plants)

SoS – Structured definition

(1) Strategic Security of Supply

1. Physical availability of primary energy sources

../..

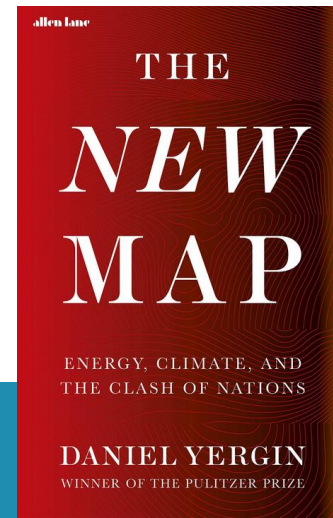
2. Sufficient investments in production capacity at production sites

../..

3. Geopolitics

unpredictable... but non negligible (... even today...)

Recall...



Security of Energy Supply

Structured Analysis

- Strategic Security of Supply
- **Adequacy**
- Sudden Cuts / Black Outs

SoS – Structured definition

(2) Adequacy – investments

= Sufficient and timely *investments*
at the consumer side (consumer countries) and or transit countries

Related to planning of infrastructure at the **consumer & transit** side

SoS – Structured definition

(2) Adequacy – investments

A – Electric power plants, HV grid, high-p NG pipelines, LV and low-p distribution grid, oil refineries, U-enrichment plants

installations need to be able to cope with baseload, peak load & variable load
(transient flexibility, variability, unpredictability)

SoS – Structured definition

(2) Adequacy – investments

A – Electric power plants, HV grid, high-p NG pipelines, LV and low-p distribution grid, oil refineries, U-enrichment plants

../..

B – Transit pipelines (NG), LNG ships, cross-border HV lines, oil-tanker fleet,...

assure more than one single route/means

SoS – Structured definition

(2) Adequacy – investments

A – Electric power plants, HV grid, high-p NG pipelines, LV and low-p distribution grid, oil refineries, U-enrichment plants

../..

B – Transit pipelines (NG), LNG ships, cross-border HV lines, oil-tanker fleet,...

../..

C – Sufficient local energy storage capacity

Oil reserves (e.g., 90 days OECD), Natural Gas reserves,
electricity storage (hydro pump stations, batteries, long-term... hydrogen??)

SoS – Structured definition

(2) Adequacy – investments

Issues that may influence / hamper “adequacy”:

- Nature of *liberalized* markets (economic risk) -- investors demand a higher IRR
- Unstable *regulatory* situation
 - Conflict with *environmental policy*
 - Obtaining construction *permits* timely or at all...
 - Uncertain regulatory character *market design*; price caps; abolish promised subsidies...
 - Legal institutions (*independent regulators, justice*)

SoS – Structured definition

(2) Adequacy – investments

Issues that may influence / hamper “adequacy”:

→ *Circumstantial* influencing elements

- Financial market expectations/tendencies (interest rates)
- Energy policy ‘expectations’ & ‘announcements’ (green papers, intentions)
- Political uncertainties (attitude of political authorities wrt private investment; ideological tensions in governments on investment choices to be made)
- Clogged supply lines of basic manufacturing ‘intermediate’ goods (semiconductor chips, construction metals/rare earth metals/minerals, ...)

SoS – Structured definition

(2) Adequacy – investments

Issues that may influence / hamper “adequacy”:

→ Availability of invested-in infrastructure to deliver? (!!)

→ **State of charge of energy stores** (release of strategic oil stock for price manipulation; Gazprom political behavior for EU Natural Gas stores, batteries during extended cold spell, Pump Hydro Storage depends on past pumping & discharge sequence)

→ **Planned outages**

→ **Correlated weather events** (GFPP & low-T in TX)

→ **Environmental temperature** (cooling capacity thermal plants)

→ **Generic flaws in facilities** (NPPs in BE and FR, Siemens CCGTs in ‘90s,...)

→ **Capacity Credit of renewables** (esp. wind & solar)

→ **Strategic & commercial behavior of market players**

→ **Sufficient & flexible fuel contracts**

SoS – Structured definition

(2) Adequacy – load management / demand response

= Organized **‘load management’** at the consumer side helps to serve the adapted (en thus requested) demand

Demand-side management (in the broad sense) helps to satisfy requested demand

SoS – Structured definition

(2) Adequacy – load management / demand response

D – Organized load management / Demand response

Reducing demand in a structured way assists in serving the requested load via **price signals**

- shifting of demanded instantaneous *power*; varying tariff structure
 - simplistic (day/night) tariff; but also real-time pricing
 - steering EV charging when abundant solar...
- organized demand-participation auctions (industries, aggregators)
- investing in more *energy* efficient equipment (at end user side)
- expected change (positive or negative) of end-use mix in the future
 - electric vehicles versus internal combustion engines (increases load)
 - replacement gas boilers by heat pumps (increases load)
 - replacing direct electric resistance heating by heat pumps (decreases load)

Security of Energy Supply

Structured Analysis

- Strategic Security of Supply
- Adequacy
- Sudden Cuts / Black Outs

SoS – Structured definition

(3) Avoiding sudden cuts (black outs)

= make sure that the overall system performs as “expected” (for end customer) even in case of unexpected events

i.e., capacity to absorb transients, dynamics, mishaps

→ issue of **reliability/security**

→ **redundancy** (e.g., N-1 rule); i.e. sufficient **investments**

but beware of correlated events (N-n); see *adequacy*

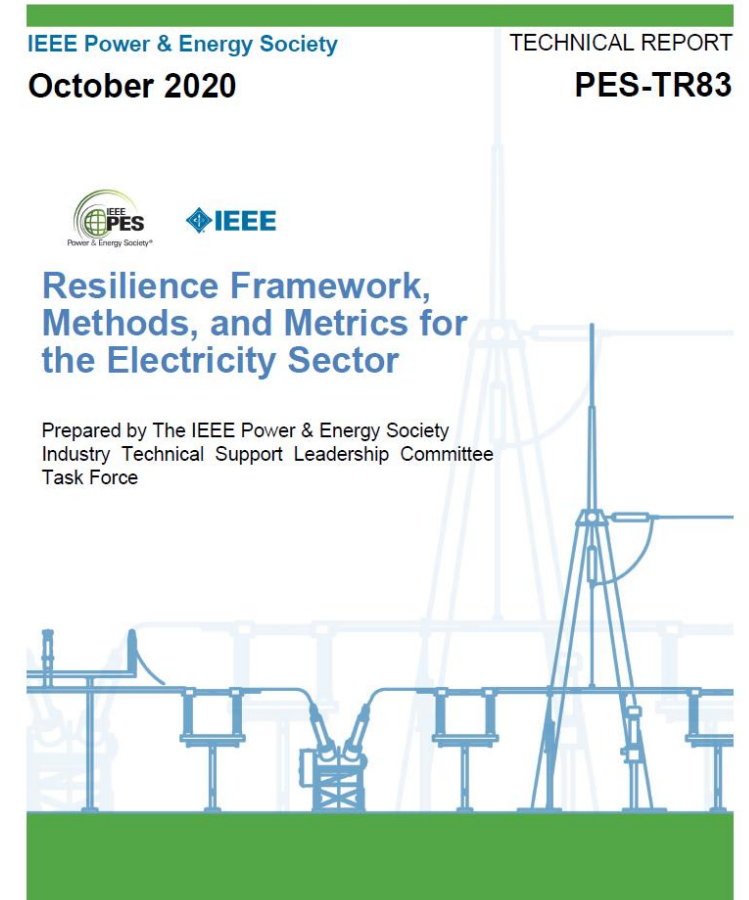
→ related to **maintenance, control strategies**,...

'Resilience'

Different definitions:

- literally:
 - to rebound, bounce back after 'collapse'
- broader:
 - includes to minimize collapse frequency & impact

In principle,
a distinction between reliability & resilience



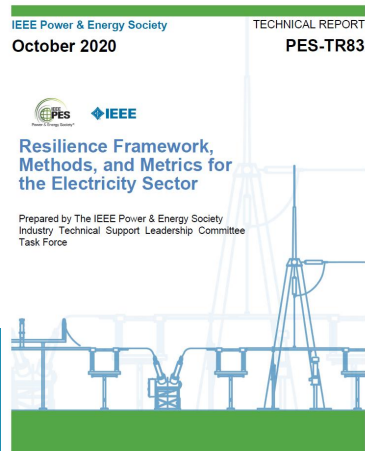
'Resilience'

3.2 Resilience Definitions

The standard/dictionary definition of resilience is “the capacity to recover from difficulties: toughness.”

The following are some industry definitions of resilience:

- FERC: “The ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such event.”
- DOE: “The ability of a power system and its components to withstand and adapt to disruptions and rapidly recover from them.”
- NATF: “The ability of the system and its components (i.e., both the equipment and human components) to minimize damage and improve recovery from non-routine disruptions, including high impact, low frequency (HILF) events, in a reasonable amount of time.”
- The IEEE Technical Report PES-TR65 and FERC Docket No. AD18-7-000 defines resilience as “The ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such an event.” (events are described in Section 2)



FYI

Interesting read from major expert and opinion maker in UK: [Michael Liebreich](#), Bloomberg NEF, ‘*The Quest for Resilience – What Could Possibly Go Wrong?*’, available at:

<https://about.bnef.com/blog/liebreich-the-quest-for-resilience-what-could-possibly-go-wrong/>



Liebreich: The Quest for Resilience – What Could Possibly Go Wrong?

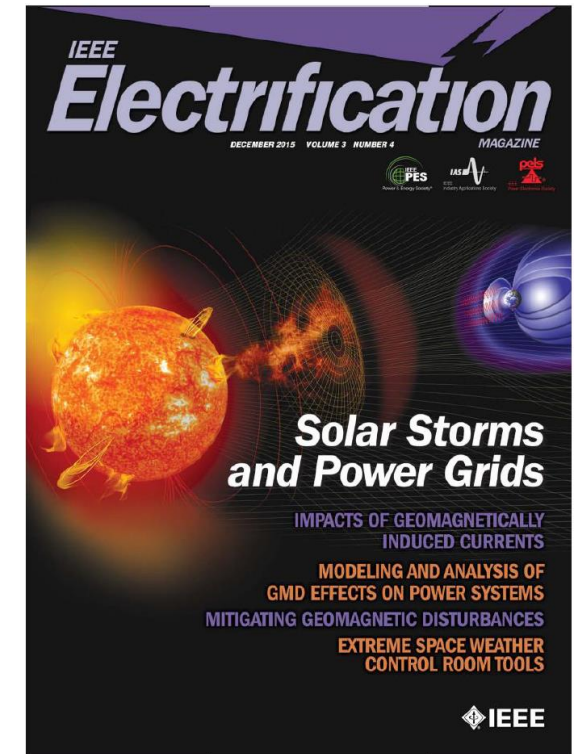


March 1, 2022

By Michael Liebreich
Senior Contributor
BloombergNEF

Liebreich recalls Security of Supply for electric power system

- He points to issues when 100% REES (cold spells/dark doldrums, monsoon & rainy seasons, hurricanes, ...)
- He calls attention to cyber security
- He warns for the unexpected (cfr. pandemic, war, solar storms, ...)
- ../..



The four R's of resilience: Resistance, Reliability, Redundancy, Recovery

→ • **Resistance** means assets must be designed to withstand the forces and disruptions they are likely to encounter. In the context of climate change, anything we build needs to take into account higher sea levels, higher temperatures, more violent storms, more frequent droughts and wildfires. In some cases, this will also prepare them to face non-climate related risks, but that must not be assumed.

WDH:
Adequacy &
Avoid Cuts

→ • **Reliability** means that assets must be able to operate within a wide range of conditions and not degrade over time. The power grid needs to continue to serve the bulk of demand – and certainly critical demand – even in the event of parts of it failing or of failures in other related systems. We need to be building a grid which, like the internet, cannot be brought down in its totality under any circumstances. We also need to invest dramatically more in the maintenance of aging infrastructure – a huge resilience issue with our without climate change.

WDH:
Avoid Cuts

→ • The importance of **Redundancy** cannot be overstated, as we saw when global supply chains were disrupted for months by one ship stuck in the Suez Canal. In a world governed exclusively by profit motives, redundancy is often squeezed out of the system and regulators may need to step in. As I first said at my 2014 BloombergNEF Summit keynote, overcapacity is a feature of the future energy system, not a bug.

WDH:
Avoid Cuts

→ • **Recovery** governs the ability of the system to adapt after it is challenged, either in real time – as when power utilities seamlessly shifted output from offices to homes during the pandemic – or by learning and adapting after incidents.

WDH:
Resilience

→ Finally, though, if we want resilience, we are going to have to pay for it. And, as New Zealand's leading futurist, Roger Dennis, put it in the context of the pandemic: "resilience is expensive in the short term, but cheap in the long term".

SoS – Structured definition

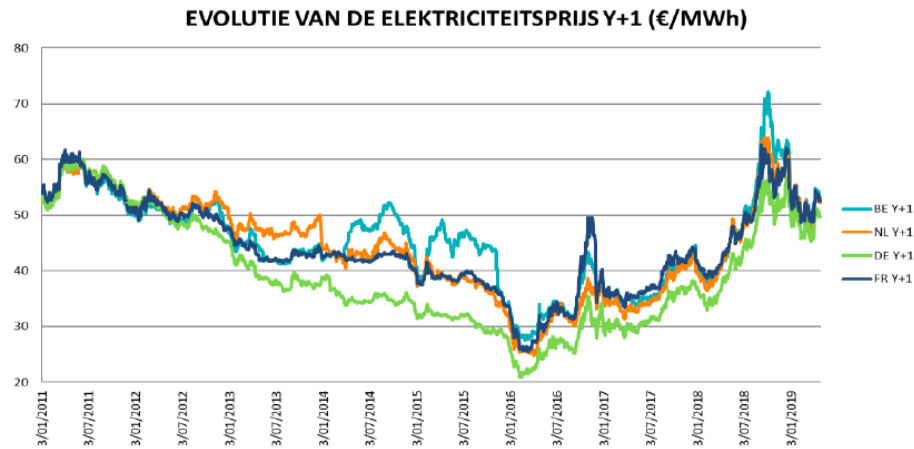
Security of energy provision – afterthought

- This should be a combination of
 - physical security of supply
 - physical provision via demand response (shift, reduction)
 - to be provided at 'affordable' prices (...purchasing power...)

SoS – Structured definition

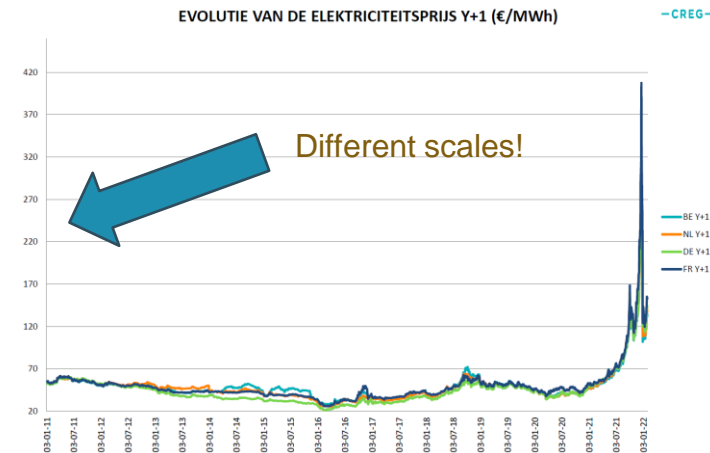
Security of energy provision – afterthought

Evolution of wholesale electricity price Y+1



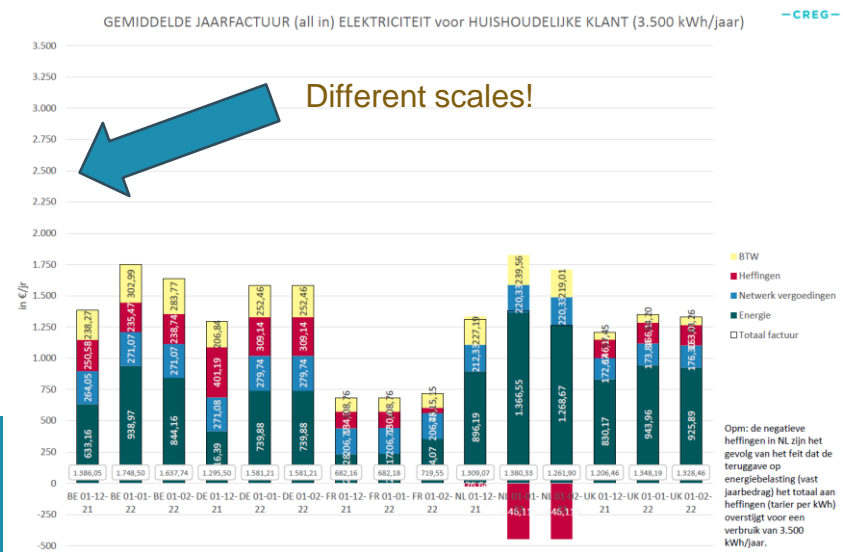
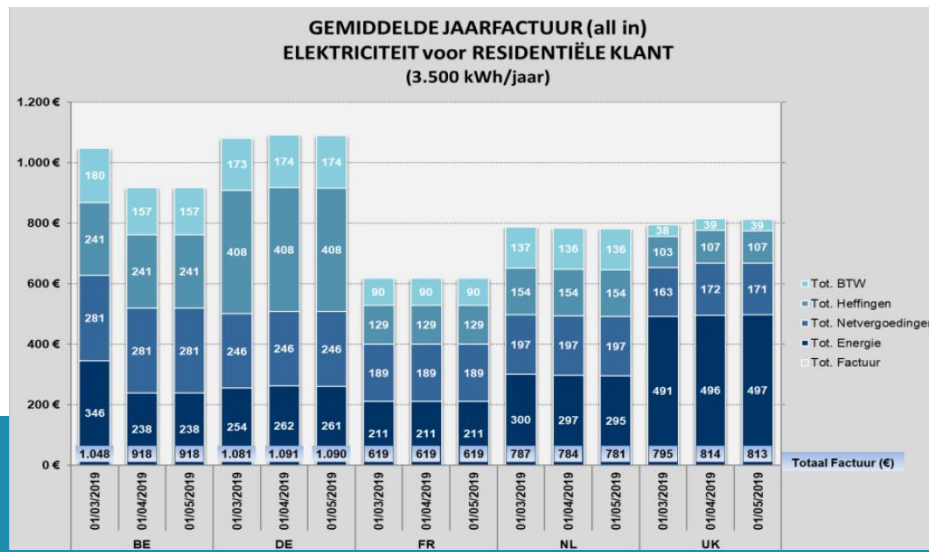
CREG, May 2019

Evolution of wholesale electricity price Y+1



CREG, Feb 2022

Average invoice electricity (all-in for one year) for residential client (3500 kWh/a)

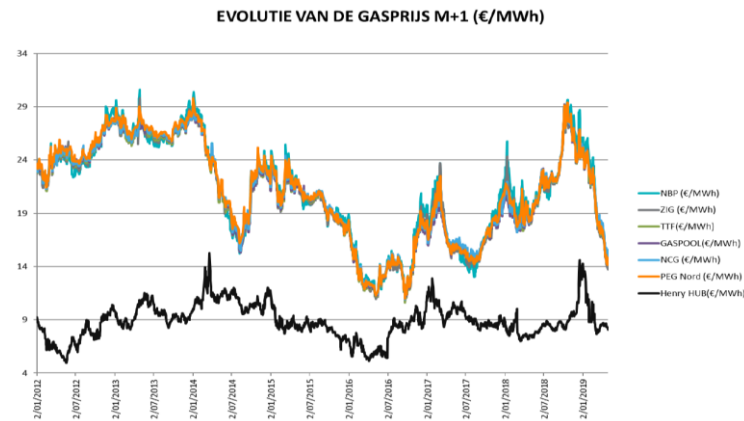


Average invoice electricity (all-in for one year) for residential client (3500 kWh/a)

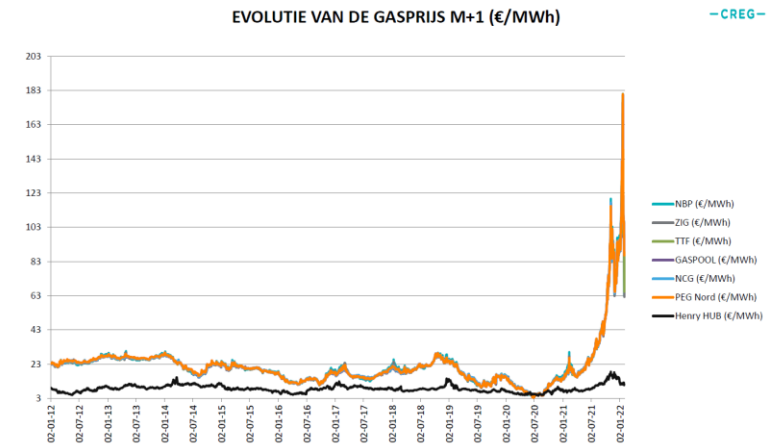
SoS – Structured definition

Security of energy provision – afterthought

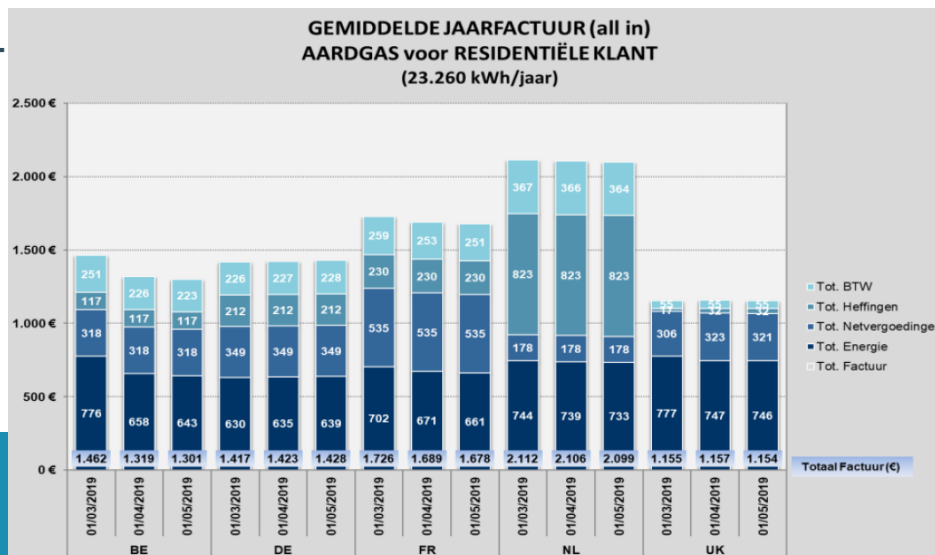
Evolution of wholesale nat gas price Y+1



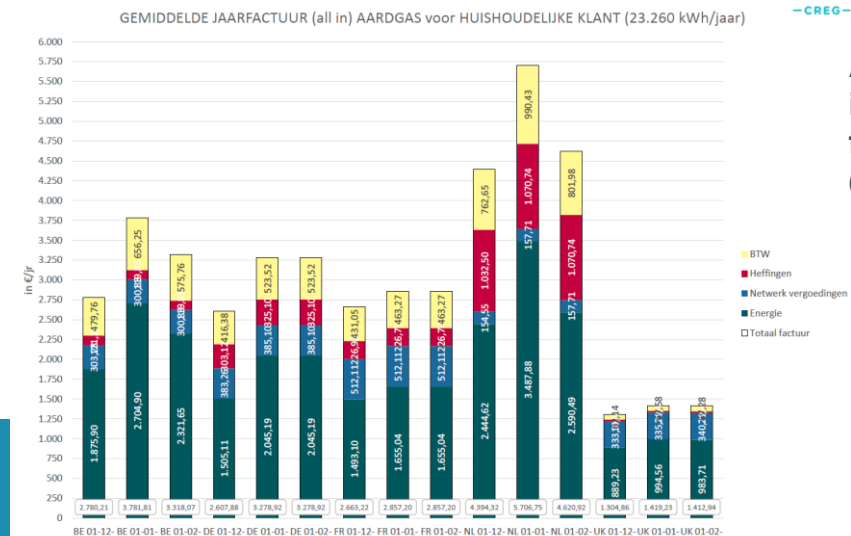
Evolution of wholesale nat gas price Y+1



CREG, May 2019



CREG, Feb 2022



Average invoice (all-in for one year) NG for residential client (23600 kWh/a)

Conclusion – Final Takeaways

- SoES has many different meanings / dimensions
- Specify precisely which aspect of SoES you refer to
- What is the meaning of physical SoES in relation to affordability?



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