International Energy Agency

World Energy Outlook 2020

Brent Wanner, Lead of WEO Power Sector Modelling and Analysis, IEA

24 October 2020

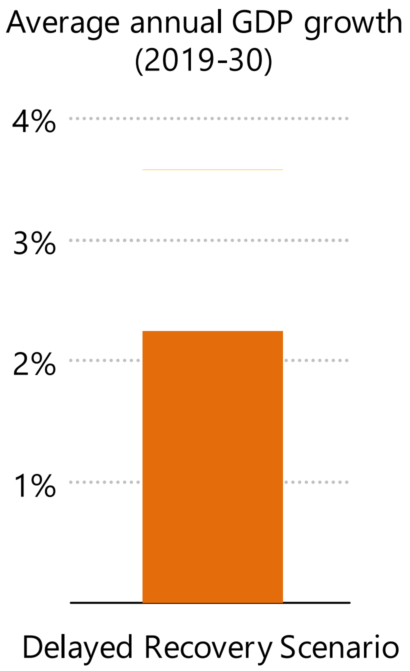
Covid-19 and the energy outlook

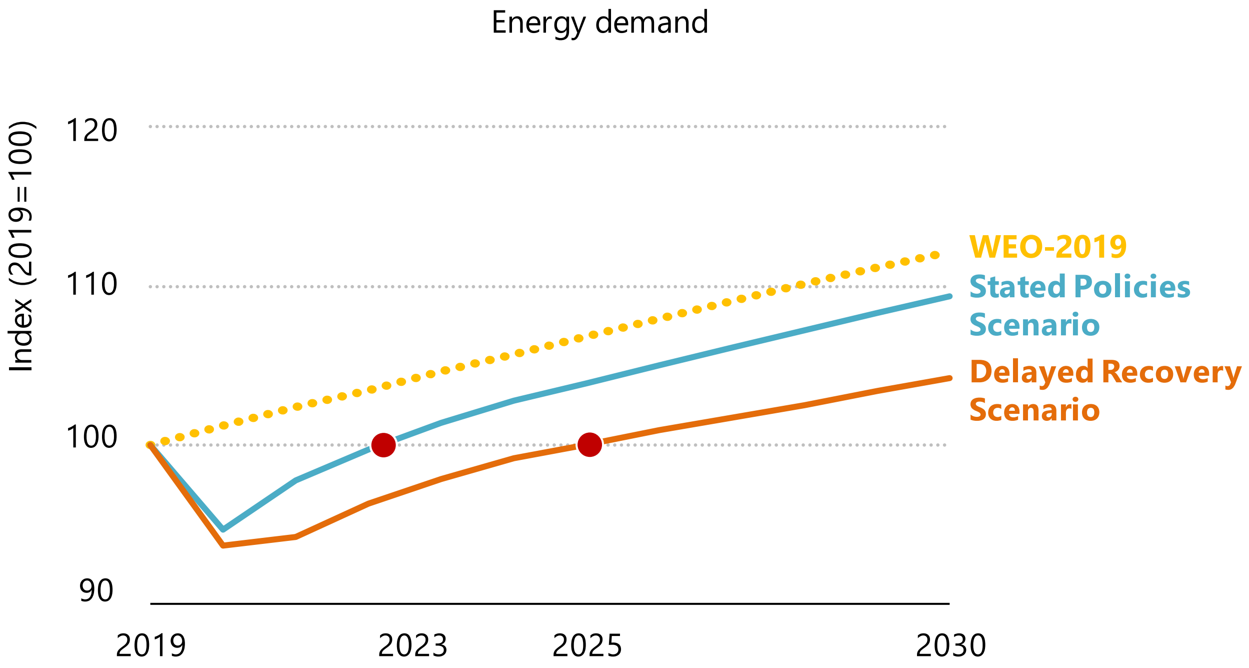
- In an extraordinary year, 2 key questions:
  - How might the pandemic (and its aftermath) **reshape the energy sector**?
  - Does this disruption help, or hinder, the **prospects for rapid clean energy transitions**?

- Focus on pathways out of today’s crisis over the next 10 years, amid 2 key uncertainties
  - **Duration and severity of the pandemic** and its economic impacts
  - **Response from energy policy makers** and the sustainability of the recovery

- Scenario-based approach more important than ever, to examine:
  - The **direction we are heading**, depending on the outlook for public health & the economy
  - What would be required to **reach net-zero emissions**

A shock to the energy system

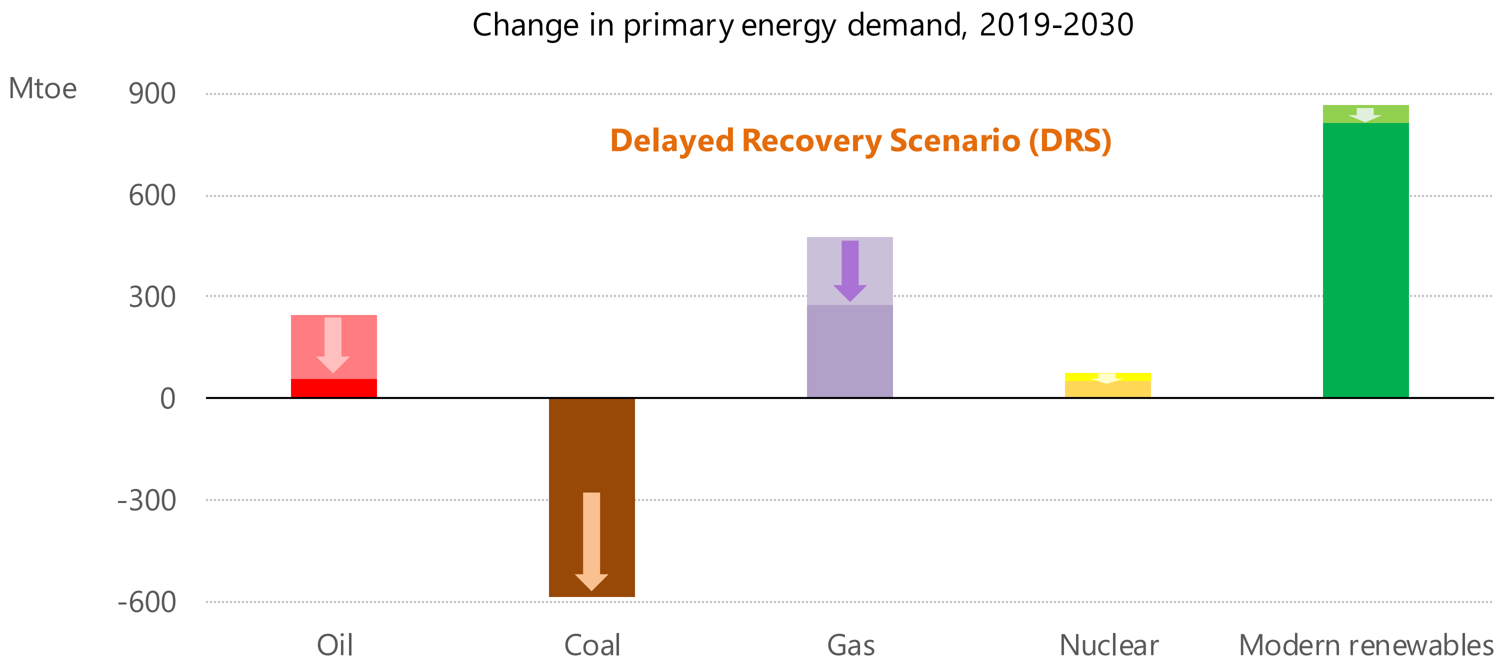




Bringing the pandemic under control in 2021 would allow energy demand to return to pre-crisis levels by early 2023. A longer pandemic would usher in the slowest decade of energy demand growth for a century

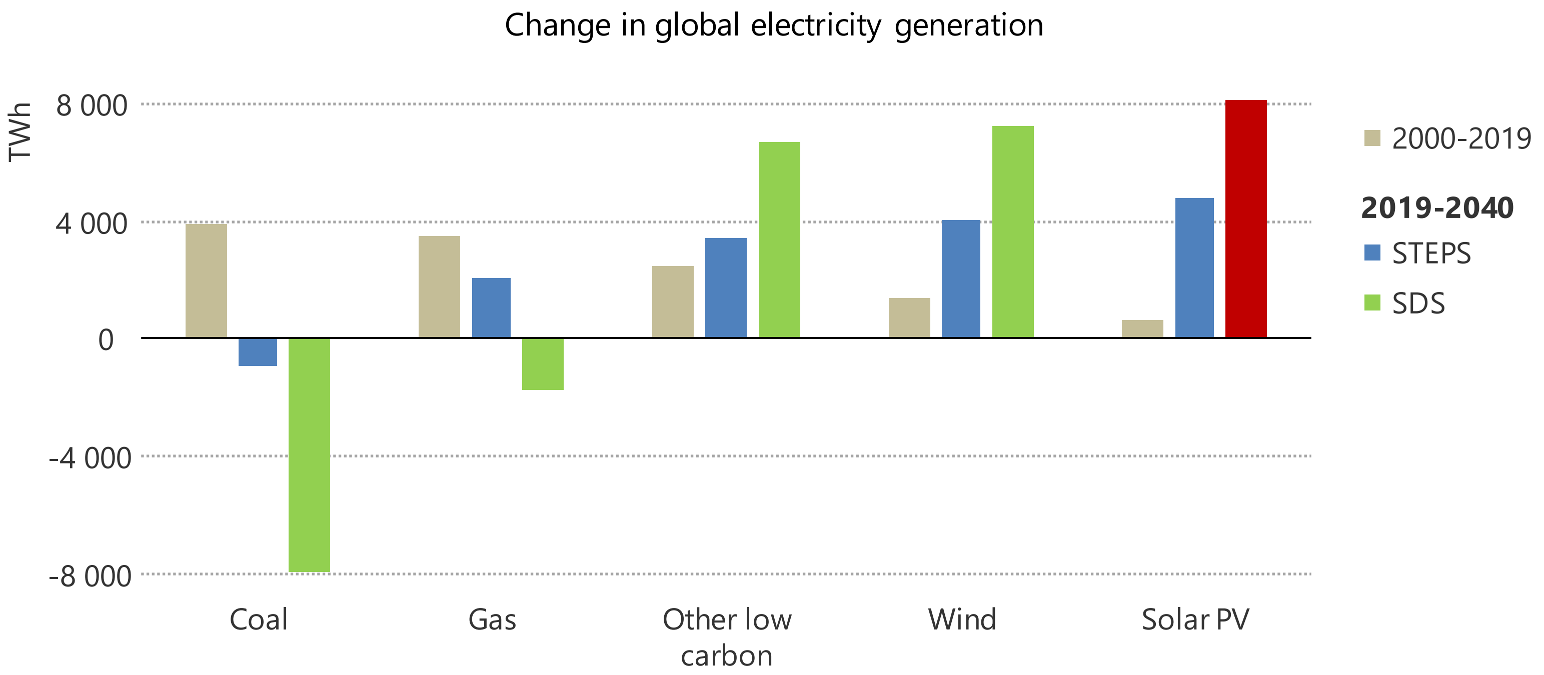
iea

Impacts vary widely by fuel & technology



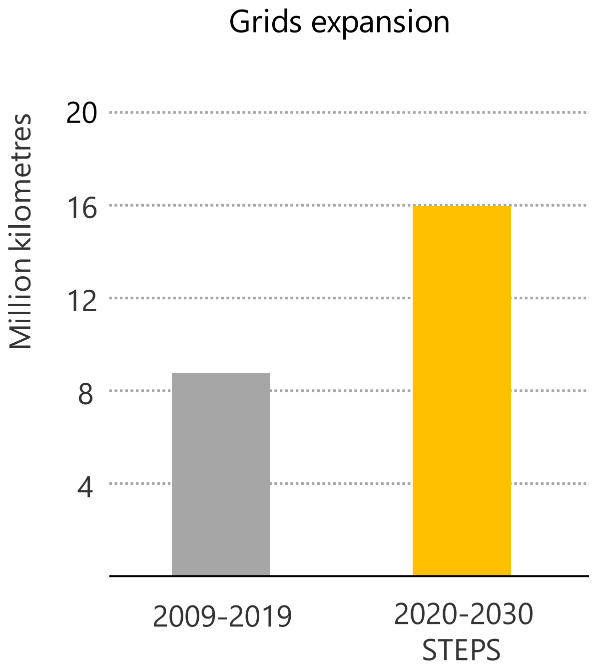
After a 5% drop in energy demand in 2020, renewables lead the rebound while coal never gets back to pre-crisis levels; a delayed recovery puts energy into slow motion, prolonging today's overhang of supply

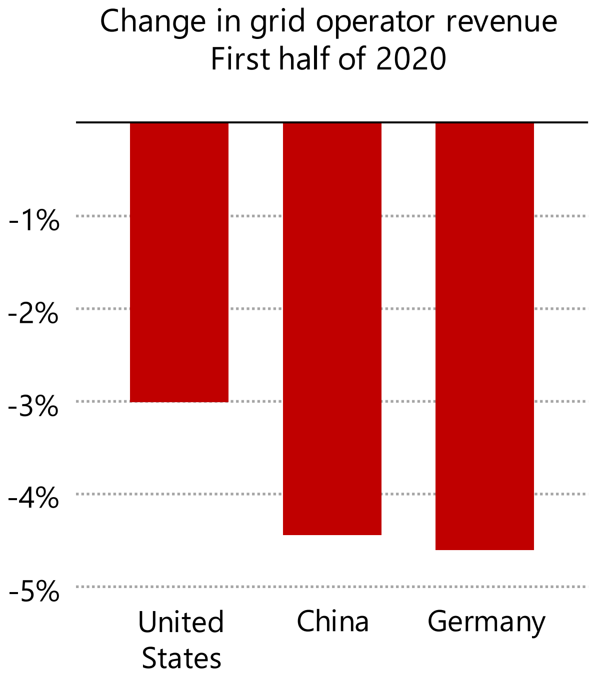
Solar PV is becoming the 'new king' of electricity



Solar PV is now the cheapest source of electricity in most countries in part due to low cost financing and is set to triple before 2030 under current and proposed policies, with the potential to grow much faster

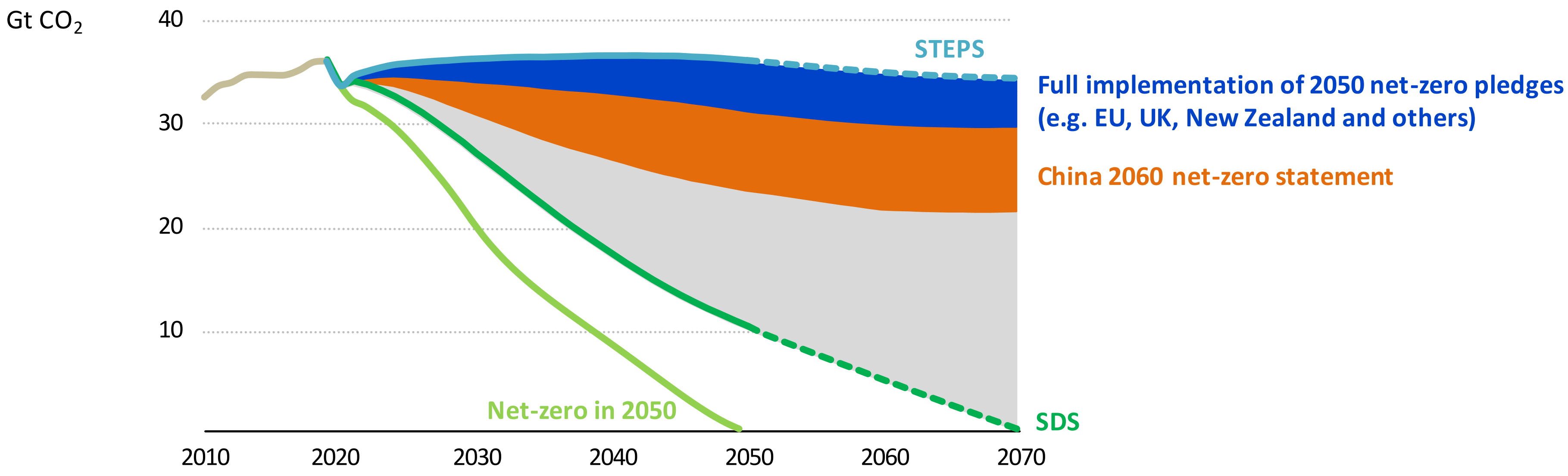
Grids are the bedrock of a clean & secure electricity future





Electricity transformations require a step up in grids expansion to ensure that electricity remains reliable, affordable and secure, however depressed revenues are creating risks for timely investment

The world is still far from putting emissions into decisive decline



Global emissions are set to bounce back more slowly than after the financial crisis of 2008-2009, but the world is still a long way from a sustainable recovery

Conclusions

- The pandemic will leave lasting scars, but it is still open whether it represents a setback for a more secure and sustainable energy system, or a catalyst that accelerates the pace of change
- Renewables have taken off, with solar leading the way. But a slowdown in improving access to electricity and a risk of under-investment in grids are warning signs for the future
- The crisis has squeezed oil and gas revenues and investment, forcing producers to reassess their strategies to align with technology and policy shifts
- Getting to net zero means ramping up clean technology deployment while continuing to reduce costs, especially through innovation for hydrogen and other low-carbon fuels, battery storage & CCUS
- There are no short cuts; only profound changes, guided by good policies, can deliver a better energy future. This is a choice – for citizens, investors, companies, but most of all for governments

3rd Edition of the Vienna Energy Strategy Dialogue

Key Note

Security Challenges in the New Energy Landscape

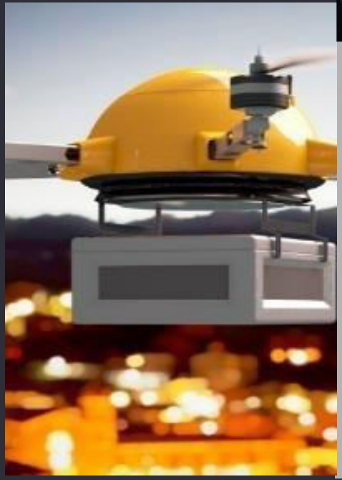
Gottfried Tonweber

24. November 2020

EY
Building a better working world

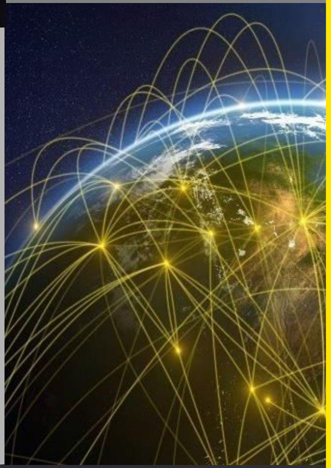
The Global energy industry is undergoing a transformation

Renewable energy generation increased by 32% in 2018 y-o-y, and it is expected to further grow at a CAGR of 7% to 2050



Global Electric Vehicle Battery Market to Reach $87. 2 Billion by 2027. Amid the COVID-19 crisis, the global market for Electric Vehicle Battery estimated at US$30. 7 Billion in the year 2020, is projected to reach a revised size of US$87.

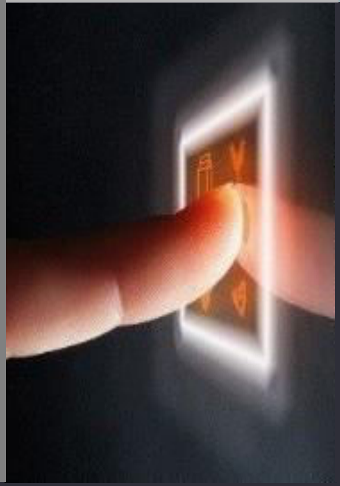
The digital oilfield market is expected to reach US$2 billion by 2022



The focus is on energy reforms, and in particular, on-privatization to improve competition, attract FDI and subsidy cuts to reduce pressure on government budgets

Smart grid investment is expected to reach US$18 billion from 2018 to 2027

Digital technologies have the potential to reduce the capital expenditure by up to 20% in the MENA Oil and Gas sector



Total cash flows are expected to improve by US$11 per barrel with the use digital technologies, across the offshore oil and gas value chain

Source: Analyst Reports, press releases, Globenew swire and internal EY SMR's

Key Global energy trends

- Smart grid and grid modernization
- Electrification of transport
- Decentralization of energy and micro grids establishment
- Uptake of energy storage
- Emergence of smart cities and 5G networks
- Increasing share of renewables in the energy mix
- Focus on new technologies
- Digitization of operational efficiency using augmented reality & drones
- Convergence of O&G and P&U
- Capital agenda
- Portfolio evolution in O&G
- Increasing demand for natural gas

Cyber Threats Impacts on Energy Companies

Loss of trust in the company's name

- Loss of trust in the sector is one of the biggest challenges
- 8 months is the average time it would take to restore an organization's reputation following a cyber incident

Operational slowdown

- Cyber attack can seriously delay the business process of the organization until the infrastructure is fixed and secured again

Loss of money and value

- Fixing the infrastructure, reputation, etc. following a cyber attack may be expensive
- Incidents in entities like Lukoil have a negative impact on the oil and gas sector stability and reputation locally and internationally

Data confidentiality

- Damage experienced by an entity in the wake of a data breach can have a lasting negative impact

Intellectual property theft

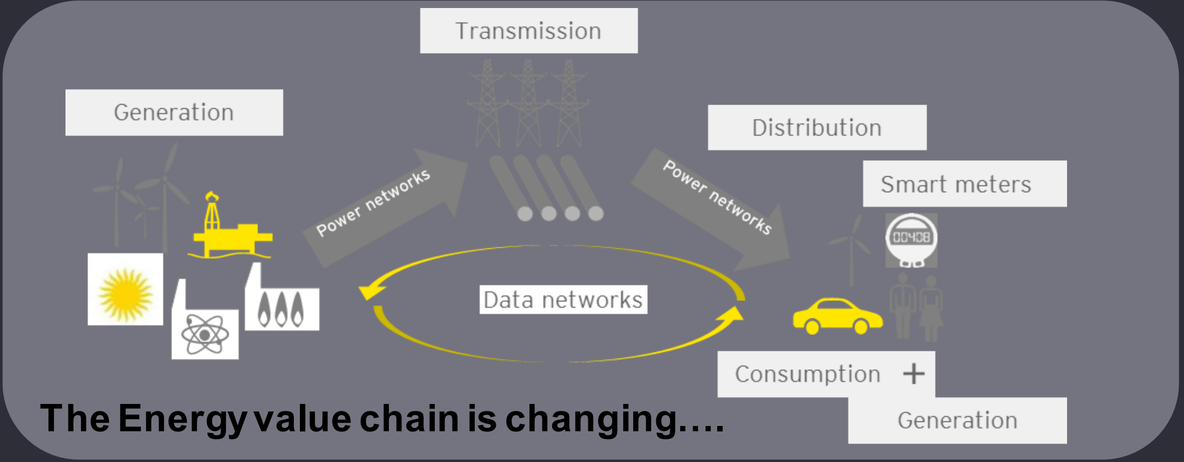
- IP theft is one of the serious issues that organizations are facing today.
- Many organizations live or die on the strength of the intellectual property they posses.

Non-compliance

- Address compliance requirements

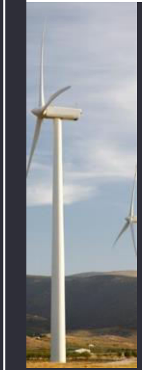
Energy market drivers

We are witnessing the birth of a new energy system which is more distributed and digitally-enabled….



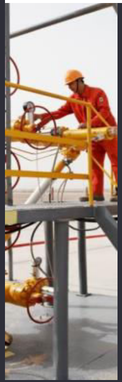
Change drivers

Electricity



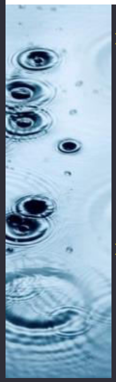
- Modernisation of infrastructure through significant investments in new technologies driven by smart metering and digital grid.
- Utilities are investing and/or partnering with other technology firms to develop new business models.

Oil & Gas



- Expansion of connected sensors and IoT in oil storage, transportation and refining.
- Increased integration of Process Control systems in gas plants with traditional IT systems.

Water



- Water utilities are behind the curve of innovation and customers have already become “digital natives” and expect a seamless digital experience.
- Cyber is major concern as attack surface expands across critical water supply infrastructure.

……resulting in significant new cyber challenges

Critical Infrastructure compromise

- Many critical systems running on OT (Operational Technology) remain unsecure/unpatched
- Heavy reliance on physical security controls
- Greater integration of OT/IT results in new entry points for attack

New NIS Regulation (Network & Information Systems Directive)

- NIS applies to Operators of Essential Services (OES) which includes many Energy clients
- New requirements for incident notification and overall increased security
- Significant fines for non-compliance (similar to GDPR)

Threat landscape increase

- Sector is extremely attractive target for state-sponsored threat actors
- Western Energy companies have been heavily targeted by sophisticated “zero-day“ attacks (e.g. BlackEnergy, Triton, Stuxnet etc.)

Third party access

- Cost reduction targets driving fragmentation and increase in 3rd party reliance
- 3rd party access to sensitive data and critical system often leads to significant cyber security incidents

Gottfried Tonweber

- ►Gottfried Tonweber joined EY Vienna In 2005 and is Leading the Cyber Security and Data Privacy practice at EY Austria
- ►Member of the Information Systems Audit and Control Association (ISACA)
- ►Highly appreciated speaker at various events with regards to Cyber Security (Industriellenvereinigung, ISACA…) and high reputation within the Austrian cyber security community
- ►Member of the Information Security Board at the university of applied sciences in St. Pölten
- ►**CISA** (Certified Information System Auditor); **CRISC** (Certified in Risk and Information Systems Control); **ISO Lead Auditor** ISO22301;BSi ISMS Auditor / Lead Auditor course ISO 27001: 2005; **Cobit Practitioner**; **Prince2** Practitioner; **ITIL** v3 Foundation
- ►Leading executive on various IoT/OT security implantation programs with the energy sector
- ►Leading executive for resilience and business continuity management within GSA (Germany, Switzerland and Austria) EY

Information and communications technology and the energy/climate transition

Jonathan Koomey, Ph.D.

Koomey Analytics

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Presented virtually at the 3rd *Vienna Energy Strategy Dialogue, On the Implications of the Global Energy Transition*

November 24, 2020

Introduction

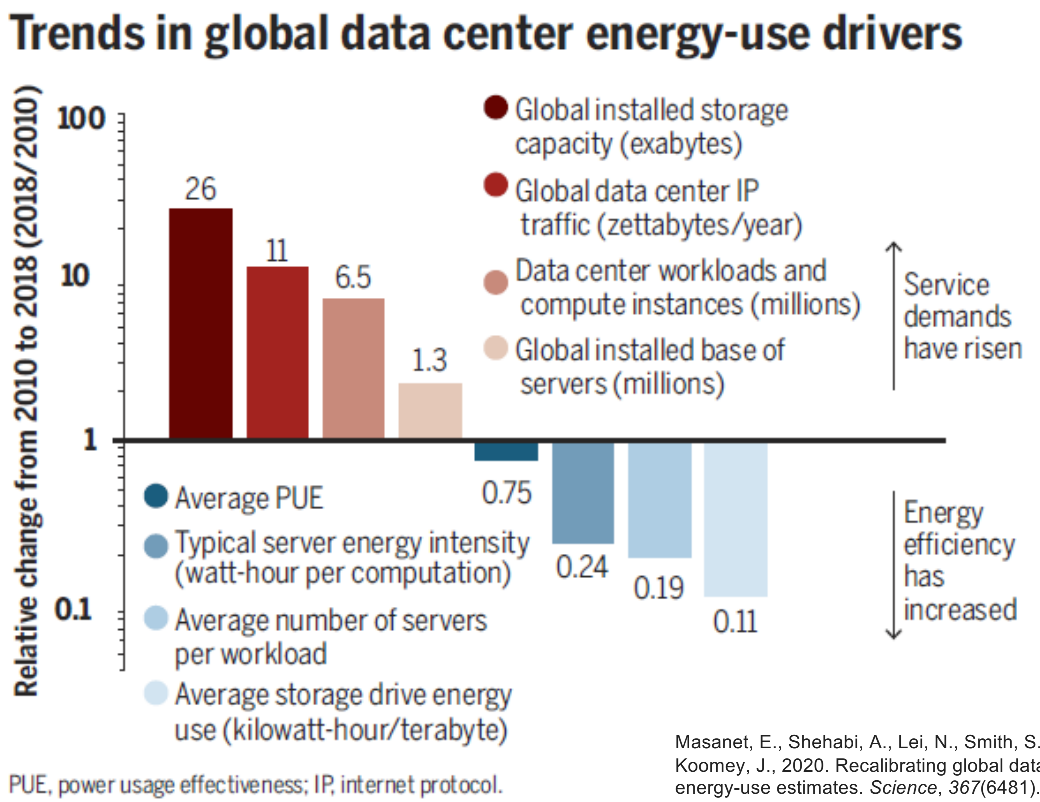
- Society needs to reduce greenhouse gas emissions to net zero by mid-century to stabilize the climate
- Information and communications technologies (ICTs) are key for achieving such rapid change in energy systems
- Two areas of interest for ICT
  - Direct electricity use
  - Indirect effects
- Direct electricity use of ICT is small and ICT’s value to society is large
- Indirect effects are likely to be much bigger than the direct electricity use, but are hard to analyze and vary a lot

ICT electricity use often exaggerated

- Long history of exaggerations in the literature
- Real data show little growth in ICT electricity use, few big environmental impacts from delivery of ICT services
  - Data centers (1% of global electricity in 2018, only 6% growth since 2010)
  - All ICT (3.6% of global electricity in 2015, no growth 2010 to 2015)
  - Telecommuting/video streaming (emissions for moving bits tiny compared to moving atoms)
  - Bitcoin (vastly exaggerated, 0.2% of global electricity use on June 30, 2018)
  - Emails (not even worth tracking)
- As computing service demands go up, efficiency goes up rapidly as well, which often offsets growth in service demand

Global data center energy modeling

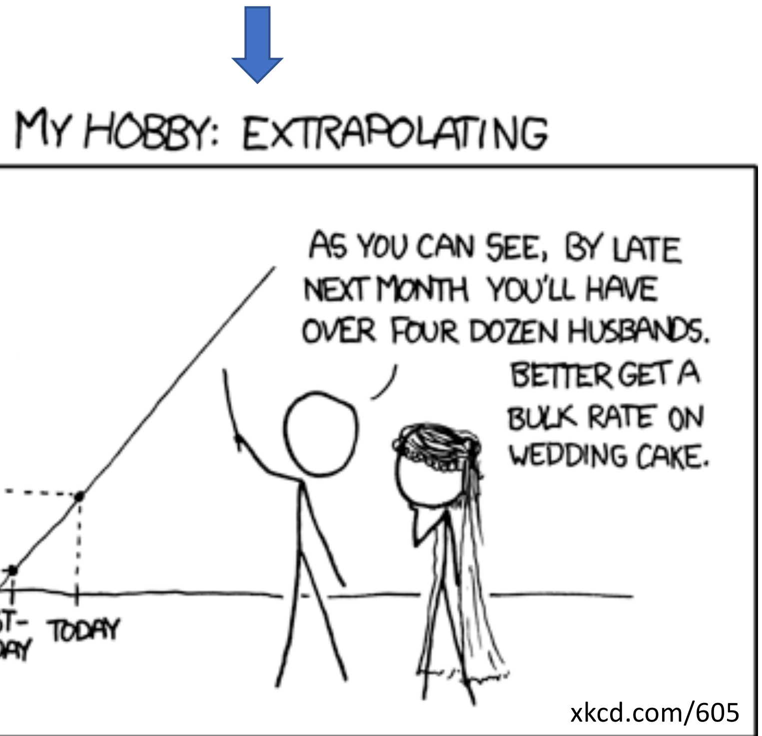
From 2010 to 2018 power demands rose just **six percent** in the time it took for compute instances to jump **550 percent**.



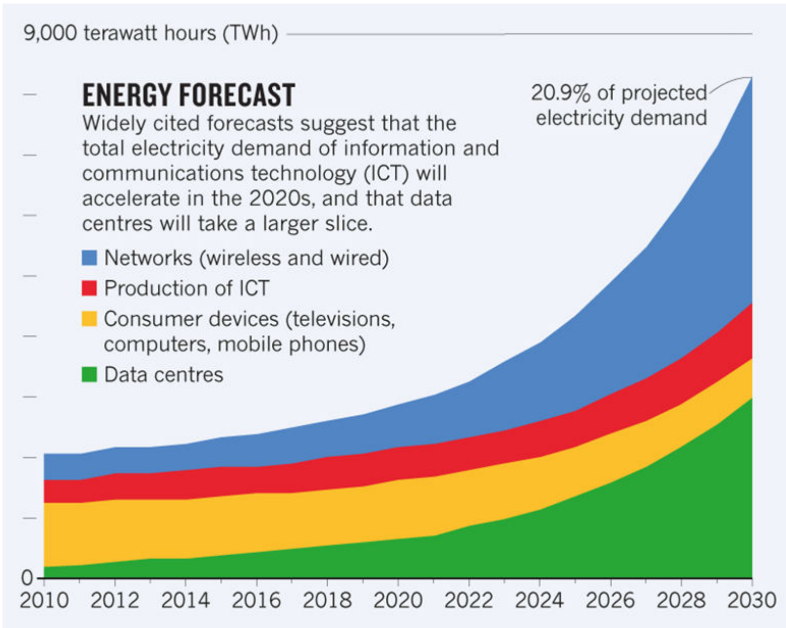
Masanet, E., Shehabi, A., Lei, N., Smith, S. and Koomey, J., 2020. Recalibrating global data center energy-use estimates. *Science*, *367*(6481).

Watch out for simple-minded extrapolations

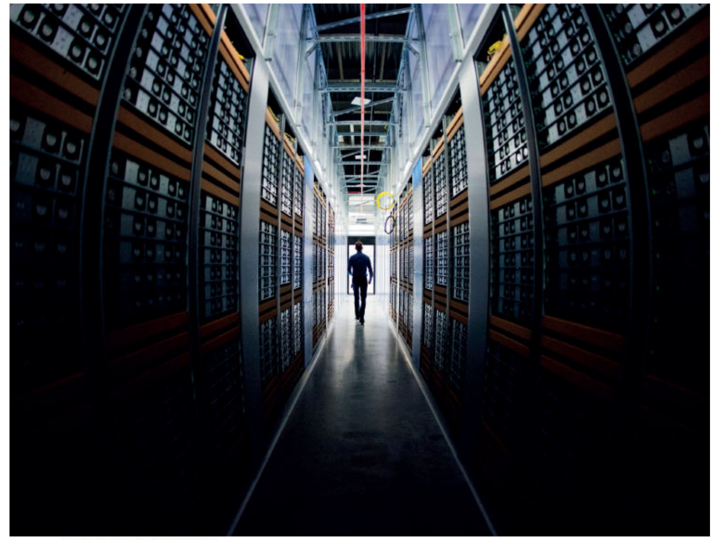
Data Limitations



Extrapolations = nonsense projections



Source: Jones, Nicola. "How to stop data centres from gobbling up the world's electricity." *Nature* 561.7722 (2018): 163.



A Facebook data centre in Luleå, Sweden.

THE INFORMATION FACTORIES

Data centres are chewing up vast amounts of energy — so researchers are trying to make them more efficient.

BY NICOLA JONES

Upload your latest holiday photos to Facebook, and there's a chance they'll end up stored in Prineville, Oregon, a small town where the firm has built three giant data centres and is planning two more. Inside these vast factories, bigger than aircraft carriers, tens of thousands of circuit boards are racked row upon row, stretching down windowless halls so long that staff ride through the corridors on scooters.

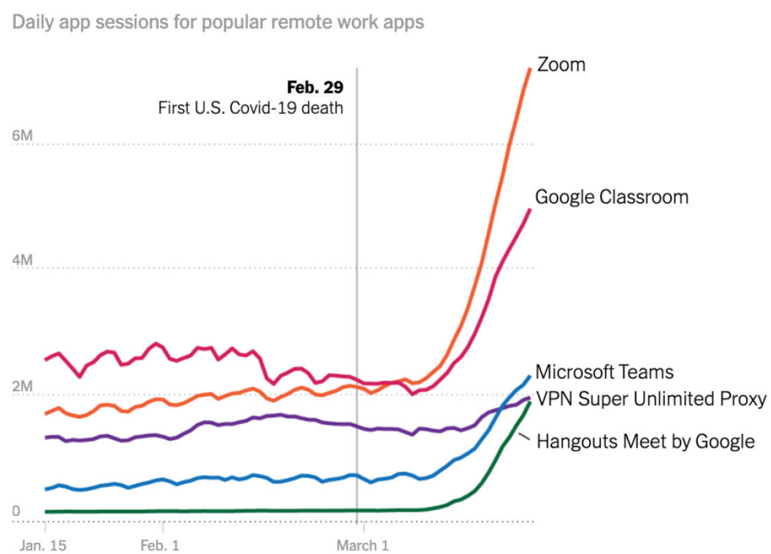
These huge buildings are the treasuries of the new industrial kings: the information traders. The five biggest global companies by market capitalization this year are currently Apple, Amazon, Alphabet, Microsoft and Facebook, replacing titans such as Shell and ExxonMobil. Although information factories might not spew out black smoke or grind greasy cogs, they are not bereft of environmental impact. As demand for Internet and mobile-phone traffic skyrockets, the information industry could lead to an explosion in energy use (see 'Energy forecast').

Already, data centres use an estimated 200 terawatt hours (TWh) each year. That is more than the national energy consumption of some countries, including Iran, but half of the electricity used for transport worldwide, and just 1% of global electricity demand (see 'Energy scale'). Data centres contribute around

Indirect ICT benefits for the energy transition

ICT is a general-purpose technology that will have broad and deep effects on the economy. Examples:

- Moving bits instead of moving atoms (Telecommuting)
- Replacing parts with smarts (Tesla Model 3 uses phone to unlock car, no traditional key)
- Collecting data (Internet of things)
- Analyzing data for real-time feedback and control (power systems control)
- Blockchain (peer-to-peer energy trading)
- Computer-aided design (for energy-using and generating products)
- Tech firms sourcing renewable electricity (reduces emissions intensity per kWh)



Koeze and Popper, *The Virus Changed the Way We Internet,* New York Times, April 7, 2020

Conclusions

- ICT is a net plus for the energy transition
  - Direct electricity consumption modest and not growing rapidly
  - More tech firms sourcing renewable electricity (emissions/kWh DOWN)
  - Indirect effects likely to be MUCH more important than direct electricity use
- Exaggerations of ICT electricity use abound, so caveat emptor
- The ICT sector changes rapidly, so extrapolations more than a few years ahead are unreliable
- General-purpose technologies transform society, and ICT is the most powerful general-purpose technology humanity has ever created

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Geopolitical and security challenges in the new energy landscape

the nuclear energy perspective

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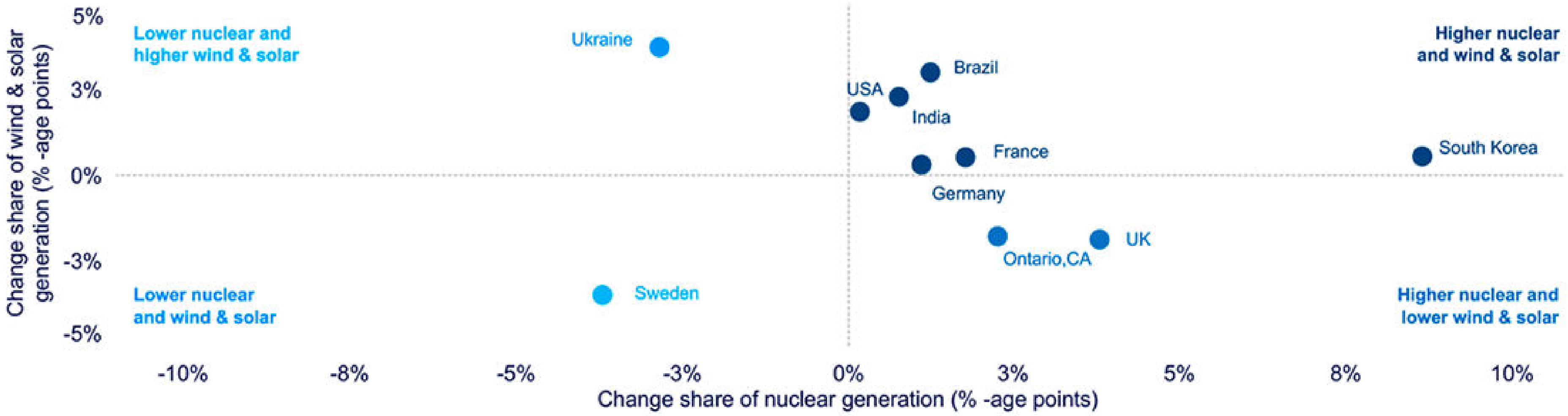
Department of Nuclear Energy
International Atomic Energy Agency

Third Vienna Energy Strategy Dialogue
Online Format
24 November 2020

Effect of COVID19 in 1st lockdown

- Nuclear power has proven resilient to the COVID19 crisis, with no country reporting the enforced shutdown a nuclear power reactor due to COVID-19.



- Higher market shares for nuclear, solar and wind power in many countries.

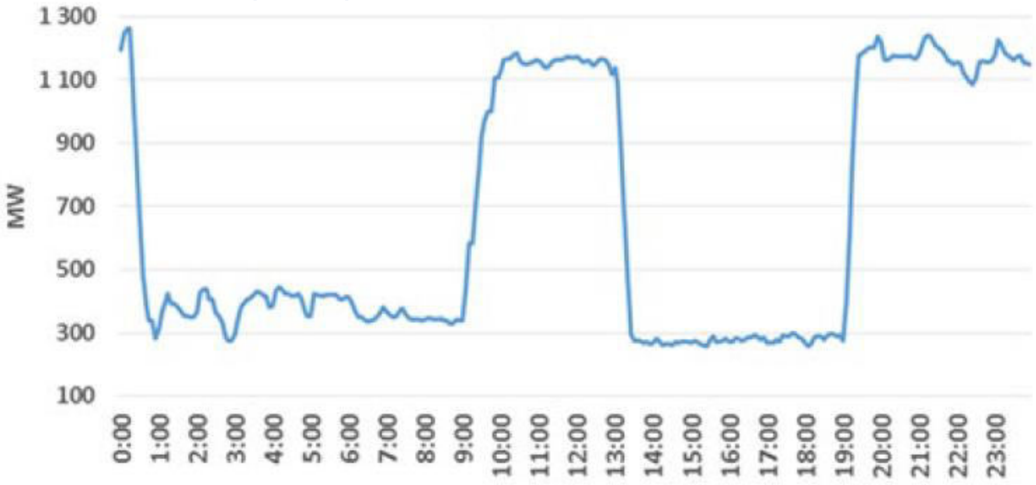
Impact on electricity prices before and after lockdown starts

- collapse in electricity demand has accelerated recent falls in electricity prices
  - impede the required investments in the clean energy transition

Need for flexibility and grid stability

- Trend accelerated by COVID19 crisis
- Additional grid stability challenges expected due to increasing shares of variable renewables
- Nuclear power plants can operate flexibly to complement variable renewable generation in a low carbon way

power level (MW)



time (hours)

Source: NICE Future, Flexible Nuclear Energy for Clean Energy Systems, 2020

Role of tech giants in leading the energy transition

From 2007:

Carbon neutrality

From 2017:

100% Renewable energy

From 2030:

24/7 Carbon-free energy

- Recognition of needs beyond VRE and batteries, including advanced nuclear,
  - For locations with limited land or renewable resources
  - To address seasonal variations

Source: Google Sustainability, 24/7 by 2030: Realizing a Carbon-free Future, September 2020

Advanced nuclear

- Improved characteristics
  - enhanced passive safety
  - fuel efficiency/waste arisings
  - economy/costs
- Over 100 nuclear power plant designs in IAEA ARIS database
  - from 17 countries
- Also products beyond electricity, e.g. hydrogen, heat
  - also as storage solutions

➡ Potential for additional contribution in creating a more sustainable, reliable, low carbon energy system.

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Atoms for Peace and Development

Thank you for your attention!

Third Vienna Energy Strategy Dialogue
Online Format
24 November 2020

THE OXFORD INSTITUTE FOR ENERGY STUDIES

Energy security and network resilience in the age of decarbonization and digitalization

Third Vienna Energy Strategy Dialogue

The Implications of the Global Energy Transition

24 November 2020

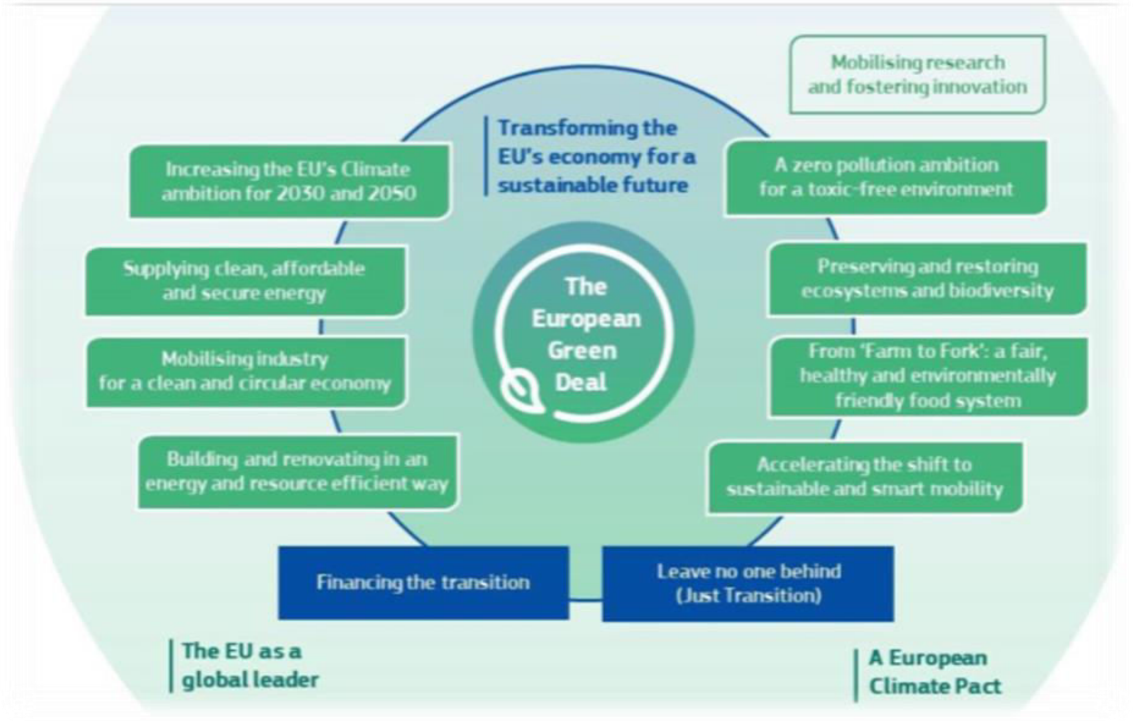
Panel II “Geopolitical and security challenges in the new energy landscape”

Dr Katja Yafimava Senior Research Fellow,
Natural Gas Research Programme

European energy (gas) security: decarbonisation becomes a priority

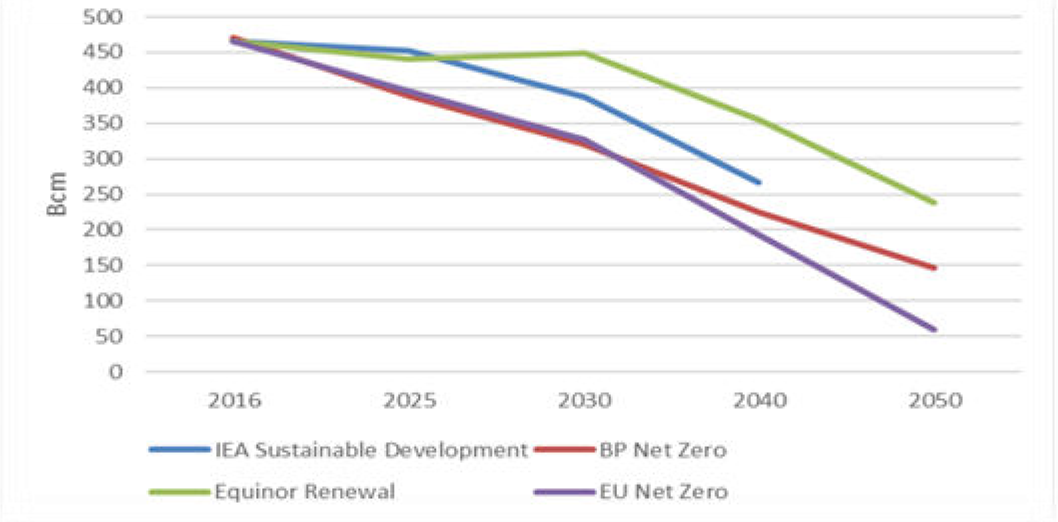
- EU Energy Security Strategy (2014); LNG and Storage Strategy (2016): the 2009 Ukraine gas transit crisis legacy
  - A successful attempt to increase resilience in the emergency situations (interconnections, reverse flows, access to LNG)
- EU Energy Union (2015): 'trilemma'
  - SECURITY OF SUPPLY: energy security, solidarity and trust
  - LIBERALISATION AND COMPETITION: a fully integrated energy market
  - CARBON REDUCTION: decarbonisation, efficiency, R&D

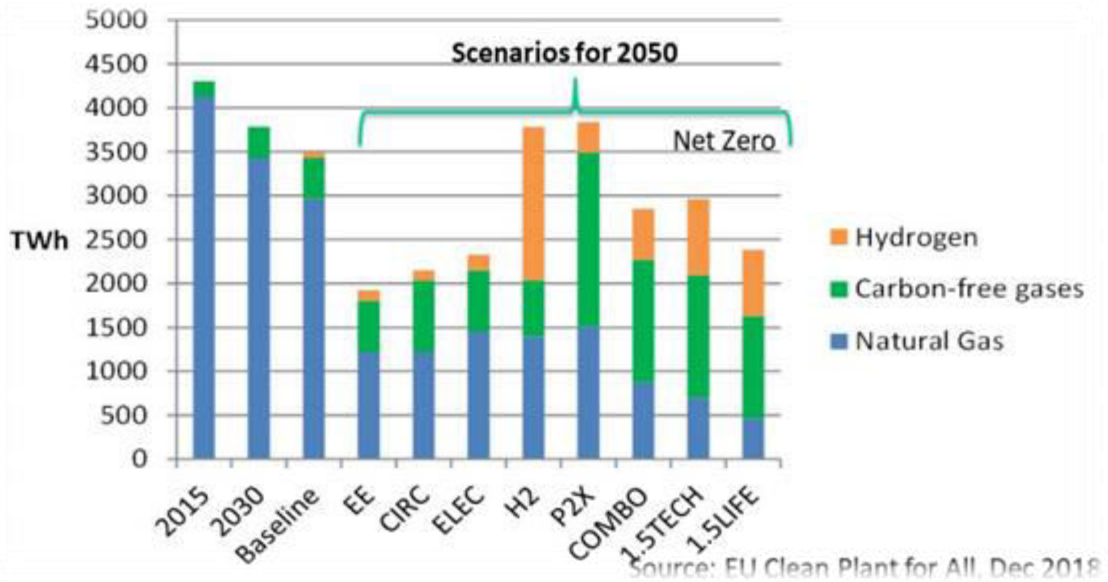
- EU Green Deal (2019)/ Clean Planet for All: "striving to the first climate neutral Continent"
  Net-Zero by 2050



Potential conflicts between carbon reduction and security of supply; security of supply and liberalisation / competition. EU Green Deal has made decarbonisation an overarching priority

European gas demand under COP21 and Net-Zero targets

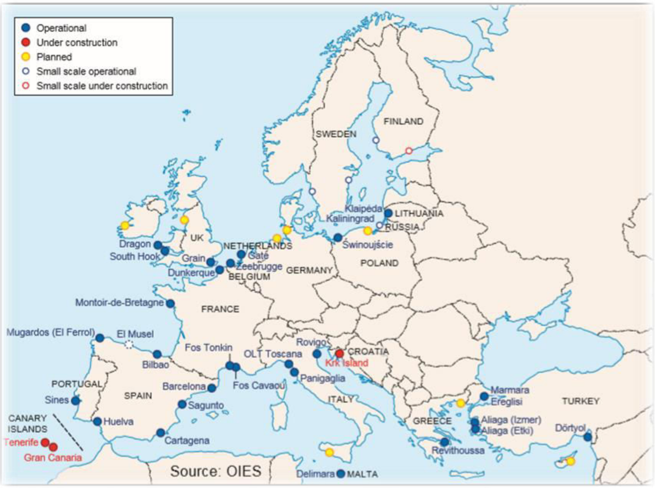


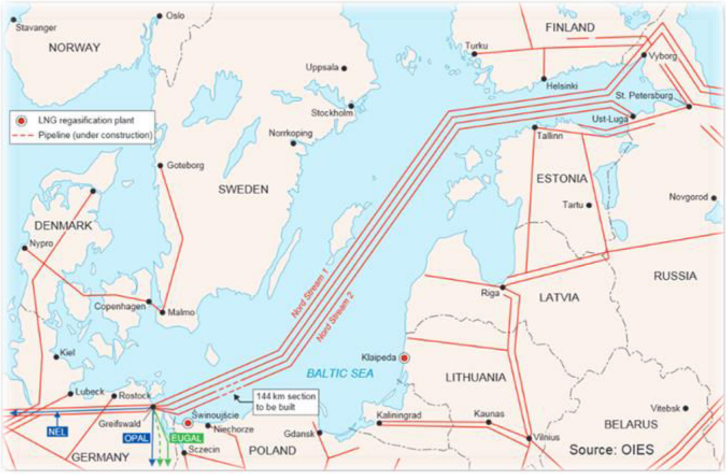


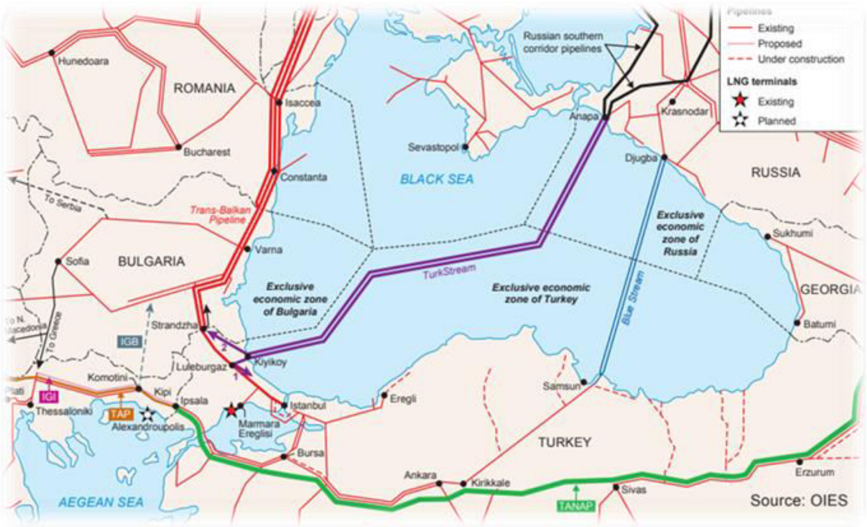
- **2020-30: COP21 demand flat or slightly declining in the 2020s whereas Net-Zero demand decline is significantly faster in the 2020s**
  - **But declining domestic production means that <u>imports (and infrastructure) will increase</u> in the 2020s to meet (even declining) demand and therefore the 2020s could be positive for gas imports**
- **Post 2030: parallel declines for both targets, accelerating in the EU scenario**
- **Scenarios show little role for <u>unabated</u> gas by 2050 under a Net Zero target**

Gas must decarbonise!

European pipeline and LNG import infrastructure





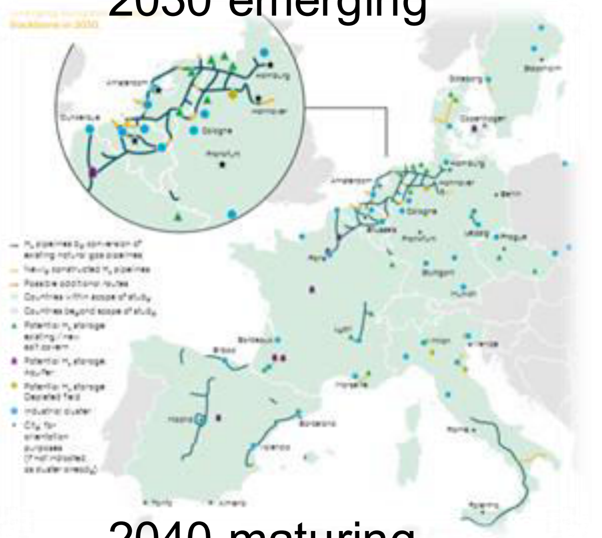


- Europe has a well-developed pipeline (Norway, Russia, Azerbaijan) and LNG (25 large scale terminals ~215 bcma) import infrastructure
- LNG allows access to a variety of sources and allows flexibility, but other countries may bid supplies away by higher prices, LNG can also serve as a storage facility, utilisation rate ~48% (2019)
- European storage capacity is distributed unevenly with winter requirements being particularly at risk from rich countries

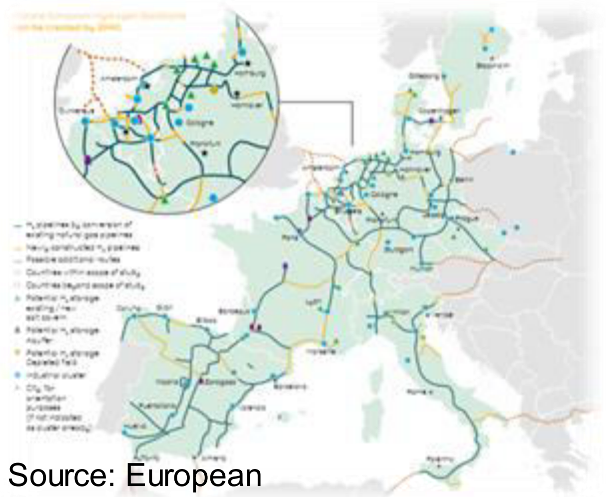
Europe has a well-developed gas infrastructure for serving increased import requirements in the 2020s but will have to adapt for transporting decarbonised gases post 2030

EU Hydrogen Strategy and European Hydrogen Backbone: creation, integration, coordination

2030 emerging



2040 maturing



Source: European Hydrogen Backbone

- Failure to develop decarbonisation model poses an existential threat for the networks but with no business case for gas decarbonisation projects at present companies reluctant to invest even in pilot projects without government support whereas more pilot projects are necessary to demonstrate that decarbonisation can be commercially viable and help to achieve Net-zero targets
  - Need for regulation facilitating cooperative value chain enabling networks and producers/suppliers to develop decarbonisation projects jointly
- EU Hydrogen Strategy outlines infrastructure requirements mostly in connection with renewable hydrogen but does not consider infrastructure needs that may arise if and as low carbon hydrogen develops at scale
- Different European countries have different hydrogen strategies, with some countries supporting renewable hydrogen (Germany, Spain) and others low carbon hydrogen (Norway, UK): coordination?
- European Hydrogen Backbone (2020)
  - Two networks will emerge: a dedicated hydrogen and a dedicated (bio)methane network

COVID's potential impact on energy transition

- Potential for COVID to accelerate the Energy Transition through "Build Back Better" but a huge increase in government intervention – both financial and regulatory – needed to make this happen
  - EU 2050 carbon neutrality via `Green Deal'
- Green Deal/Net Zero policy implementation will continue but (probably) with some delays
  - but Green Deal documents will not be transposed into legislation until 2024
  - unclear how much of the recovery instrument money will be devoted to which energy sectors: power, transport, buildings

Thank you!

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For relevant publications see https://www.oxfordenergy.org/authors/katja-yafimava/

https://www.oxfordenergy.org/publications/eu-hydrogen-vision-regulatory-opportunities-and-challenges/

https://www.oxfordenergy.org/publications/finding-a-home-for-global-lng-in-europe-understanding-the-complexity-of-access-rules-for-eu-import-terminals/

https://www.oxfordenergy.org/publications/building-new-gas-transportation-infrastructure-eu-rules-game/

“PANEL II: GEOPOLITICAL AND SECURITY CHALLENGES IN THE NEW ENERGY LANDSCAPE“

THIRD VIENNA ENERGY STRATEGY DIALOGUE

24TH NOVEMBER 2020, VIENNA, AUSTRIA

ASSESSING ENERGY DEPENDENCY IN THE AGE OF HYBRID THREATS

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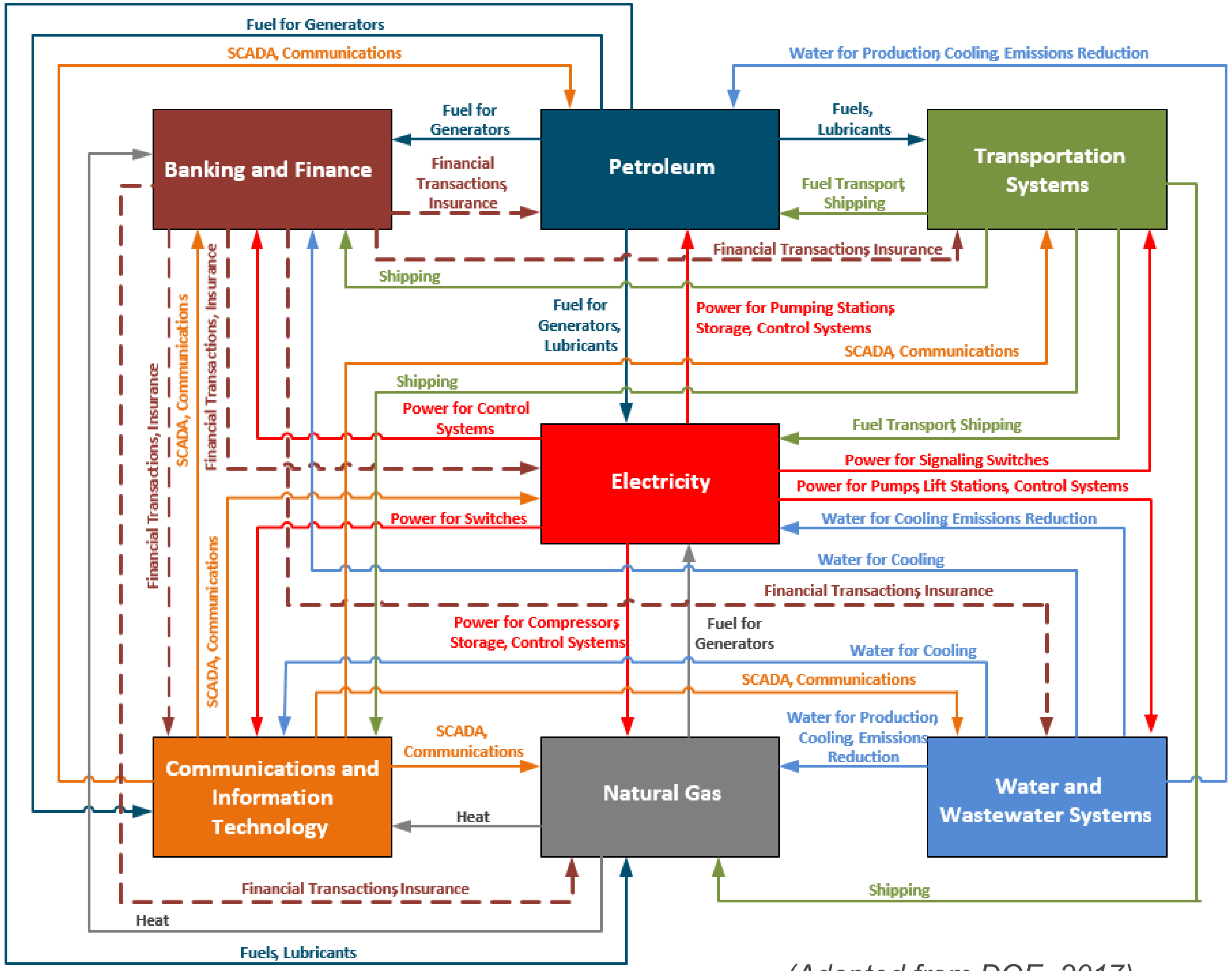
INFRASTRUCTURE INTERDEPENDENCIES



(Adapted from DOE, 2017)

Energy infrastructure is highly interdependent with other sectors

INTERDEPENDENCIES CONSTITUTE A RISK MULTIPLIER

Effect of Critical Infrastructure Interdependencies on Risk

(Petit et al., 2015)

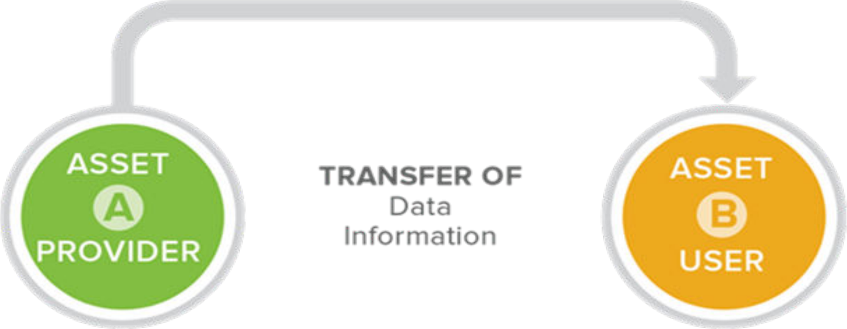
DEPENDENCY CLASSES

RINALDI, PEERENBOOM, AND KELLY (2001)

Physical Dependencies

(Petit et al. 2015)

Cyber Dependencies

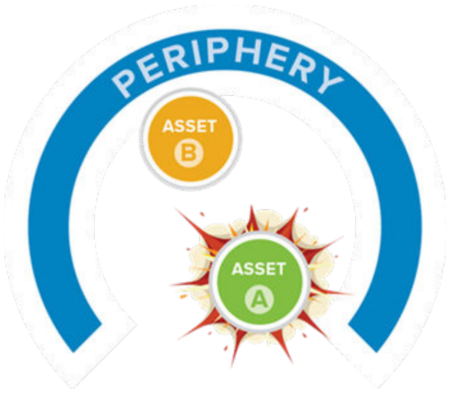


(Petit et al. 2015)

DEPENDENCY CLASSES

RINALDI, PEERENBOOM, AND KELLY (2001)

Geographic Dependencies



(Petit et al. 2015)

Logical Dependencies

(Petit et al. 2015)

GEOPOLITICAL DEPENDENCY

VERNER, GRIGAS, PETIT (2019)

Politics of Interdependence

Symmetry in the dependence of a supplier and a consumer reflects:

- The size of both markets
- The degree to which each side has alternative import or export opportunities

The relationship often results in stable supplies less vulnerable to political shifts

Politics of Supply

Balance between the supplier and importer nations is in favor of the supplier

Supplier nations typically negotiate from a position of strength

Supplier nations can advance their national, economic, political, and security interests

GEOPOLITICAL DEPENDENCY

VERNER, GRIGAS, PETIT (2019)

Politics of Dependence

When the interdependence of suppliers and importing nations is asymmetric, importing countries are vulnerable to the “politics of dependence”

These countries often operate from a position of weakness because they are disproportionately reliant on a limited set of energy-producing or -exporting nation(s), supply routes, or infrastructure

Politics of Demand

When an importing country operates from a position of strength because it imports large volumes of a commodity or has a number of diversified suppliers

Can depend on whether it is a buyer’s or seller’s market

GEOPOLITICAL DEPENDENCY

VERNER, GRIGAS, PETIT (2019)

Politics of Transit

Transit countries collect fees for operating energy infrastructure

They can use energy supplies as leverage by destabilizing the transport through their territory

Historically, transit states have relied on land-based pipelines or rail or truck deliveries

However, the boom of tankers carrying oil and LNG has added the element of international waters to the equation

OPTIMAL ENERGY DEPENDENCY ANALYSIS TO COMBAT HYBRID THREATS

General overview of the data, analysis, and output

Data Collection	Analysis	Output
Includes both geopolitical dependency categories and critical infrastructure dependency classes. Collected through a variety of mechanisms, including surveys, academic research, and open source information.	Integrates infrastructure modeling and failure analysis, including cascading and escalating failures. Considers the fungibility of energy resources, market conditions, and other dynamic factors.	Enhanced situational awareness of hybrid threats to energy systems. Integrated understanding of potential cascading and escalating failures from the local to the global level. Insight into hybrid-threat actors' capabilities and intentions.

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