# Where to start in energy policy and geopolitics?

A FEW FUNDAMENTALS NOTIONS

SAMUELE FURFARI JOINT EPS-SIF-INTERNATIONAL SCHOOL ON ENERGY VARENNA, JULY 2023

Crediti: Glass painting by Fritz Wagner, "Komposition HG 1/15", 2019



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# Energy keywords





# Energy in the Versailles Treaty



SECTION IV. - Bassin de la Sarre.

ART. 45. — En compensation de la destruction des mines de charbon dans le nord de la France, et à valoir sur le montant de la réparation des dommages de guerre dus par l'Allemagne, celle-ci cède à la France la propriété entière et absolue, franche et quitte de toutes dettes ou charges, avec droit exclusif d'exploitation, des mines de charbon situées dans le bassin de la Sarre, délimité comme il est dit à l'article 48.



Dans cette retree Galerie des Glaces ou, le 18 janeiar 1871, Guillaunie I<sup>e</sup> electroieux s'était proclamé amperant, l'Allernague de Guillaume II vaineu a paraphé su soumitation aux règles universeller de la Justice et du Droit.







THE ECONOMIC CONSEQUENCES OF THE PEACE

JOHN MAYNARD KEYNES, C.B.



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HARCOURT, BRACE AND HOWF 1920



# Energy is the fundament of the construction of the EU





Robert Schuman (izquierda) y Jean Monnet

- Schuman Declaration of 9 May 1950
- European Coal and Steel Community (ECSC): reJuly 1952 - July 2002
  - Create a true internal market for coal
  - Social measures: safety, housing finance
  - Research Promotion coal and steel.
  - phasing-in actions under the ECSC Treaty of Nice.



#### Messina Conference 1 & 2 June 1955



"There will be no future for the European Community without cheap and abundant energy"

#### LACROIX

#### Accueil > Monde

#### Frans Timmermans: « Le nucléaire est "zéro émission", mais il n'est pas vert pour autant »

Entretien Numéro deux de la Commission européenne dont il est le « monsieur environnement », le Néerlandais Frans Timmermans appelle la France et les autres États membres à une attitude rationnelle sur leurs choix énergétiques en vue des objectifs climatiques. Sceptique sur le nucléaire, il invite les Vingt-Sept à faire la part belle aux énergies renouvelables.

Recueilli par Céline Schoen pour La Croix (France), Ruurd Ubels du Nederlands Dagblad (Pays-Bas) et Giovanni Maria Del Re d'Avvenire (Italie), le 22/12/2021 à 05:58 Modifié le 22/12/2021 à 12:07

Ecture en 5 min.

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2005-2022 QU'AVONS-NOUS RÉELLEMENT VU

#### Nuclear is a fossil fuel [interview L'Opinion 4 nov 2021]

S'abo







# Energy in Lisbon Treaty: Article 194 • Article 194-1



- (a) ensure the functioning of the energy market;
- (b) ensure security of energy supply in the Union; and(c) promote energy efficiency and energy saving and the
- development of new and renewable forms of energy; and
- (d) promote the interconnection of energy networks.



# Energy in Lisbon Treaty: Article 194.2



#### • Article 194-2

- Without prejudice to the application of other provisions of the Treaties, the European Parliament and the Council, acting in accordance with the ordinary legislative procedure, shall establish the measures necessary to achieve the objectives in paragraph 1. Such measures shall be adopted after consultation of the Economic and Social Committee and the Committee of the Regions.
- Such measures shall not affect a Member State's right to determine the conditions for exploiting its energy resources, its choice between different energy sources and the general structure of its energy supply, without prejudice to Article 175(2)(c).





By way of derogation from paragraph 2, the Council, acting in accordance with a special legislative procedure, shall unanimously and after consulting the European Parliament, establish the measures referred to therein when they are primarily of <u>a fiscal nature</u>."

• Article 194-3



Energy in Lisbon Treaty: Article 194.3

# EU 2000's strategy to improve the Security of supply No illusions... the EU will not become independent! SoS is not the dream to reduce this dependence but to improve its management. To avoid any disruption, it is necessary to: Diversify... Diversify energy security of energy su sources **Diversify** suppliers Diversify routes







No mention at all of nuclear anergy

Importing from Ukraine | electricity, H<sub>2</sub>

More wind and more solar PV

Energy efficiency | buildings, Heat pumps

#### Hydrogen

#### More non-Russian gas

#### **REPower EU May 2022**

- €300 billion in financing
  - €72 billion in the form of grants
  - €228 billion in loans



# **Fundamental notions**



What is energy? Work  $\equiv$  energy  $\overrightarrow{w} = \overrightarrow{F} \cdot \overrightarrow{d}$   $\overrightarrow{w} = \int \overrightarrow{F} \cdot \overrightarrow{du}$ [1 Joule = 1 Newton x 1 metro]



d (m)



F (Newton)

# 150 h/m × 100 W = 15000 W = 1,6 l gasoline

Wednesday

≅ 3,5 €

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#### Sub Saharan Africa agriculture energy supply

#### $30 \text{ million } \times 100 \times 7.36 = 22 \text{ billion}$

•



Claude Stéphane SIDE et Michel HAVARD, DEVELOPPER DURABLEMENT LA MECANISATION POUR AMELIORER LA PRODUCTIVITE DE L'AGRICULTURE FAMILIALE EN AFRIQUE SUBSAHARIENNE, INTERNATIONAL JOURNAL OF ADVANCED STUDIES AND RESEARCH IN AFRICA, https://agritrop.cirad.fr/577133/1/Side%20Havard%20int%20J.%20Advance%20Studies%202015%20mecanisation%20agricole.pdf SAMUEL FURFARI - ESCP



# 40% OF WORLD POPULATION (2.7 BILLION) DEPENDS OF TRADITIONAL BIOMASS

Samuele Furfari

L'URGENCE D'ÉLECTRI FIER L'AFRIQUE Pour un vrai développement durable

L'Harmattan

Photo: O. Furfari

St.

SAMUEL FURFARI - ESCP

## Energy is life and quality of life





# Primary energy and final energy





# Breakdown of EU final energy demand





Where do we use the final energy? **Final energy use** 3 final services and 5 sectors





# Gas $\cong$ heating (thermal use)







#### Energy policy fundamentals to keep in mind at all times





# Some measurement units in energy policy

Type of energy	Unit
International System	Joule (J) → EJ (10 <sup>18</sup> )
Oil	Tonne oil equivalent (toe) = 41.8 GJ 1 barrel = 159 litres 1 toe = 1 165 litres = 7.33 b 1 Mtoe/day = 20 000 b/d
Natural gas	1 bcm (G.m <sup>3</sup> ) = 0.9 Mtoe = 1.73 Mt of LNG = 6.29 Mb
Coal	<ul> <li>1 tonne of coal equivalent</li> <li>(tce) contains 23.3 GJ or 0.55</li> <li>toe</li> <li>1 tonne of lignite is equivalent</li> <li>to 1/3 of toe</li> </ul>
Electricity	1 mega watthour (MWh) = 1 000 kWh = $10^6$ Wh = 3.6 GJ

# The others "units" of energy

Туре	"Unit"
Unit of Time	Ten years
Unit of Account	Billion €/\$
Unit of Space	The world





#### Continued growth in energy demand ... except in times of crisis





## Continued growth in demandofor all energy sources



## Energy consumption per capita = f (world GDP)





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#### Growing demand from outside the EU



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# Primary energy consumption in the EU and the world EU World



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# Conventional energy growing faster than new energy



Between 2011 and 2022, energy consumption in non-OECD countries increased by 87 EJ and in OECD countries by 3 EJ. Percentage increase in Non-OECD energy demand from 2011 to 2022



## The ongoing quest for efficiency





#### Evolution of the global energy consumption and the energy intensity





(2022 BP data)
### 30 years of new renewable energy promotion by the EU





## The renewable fuel mix reality in the EU





## Intermittent and variable electricity generation or MW are not MWh





# Average on 5 yearsWindSolarLoad factor in the EU23 %11 %



S. Furfari, and A. Clerici, "Green hydrogen: the crucial performance of electrolysers fed by variable and intermittent renewable electricity," Eur. Phys. J. Plus (2021) 136:509, Mai 2021



### Electricity generation in Germany (Eurostat data)

Rationalfogialififche Bibliothet / Beft 38 Orrousgeber: Bottfrie Beber, M. s. OL

Vmp.

Technif und Wirtschaft im Dritten Reich Ein Arbeitsbeschaffungsprogramm

> Bon Dr.-Ing. Franz Lawaczed





Berlag Bry. Eber Rachf., O. m. b. S., München 2, NO.





## Impact of the network cost on electricity price



Domestic electricity prices for 100 kWh (euros) according to the percentage of renewable energy (solar and wind). Eurostat 2020 data



## How important is wind power and solar energy?





#### 2 Springer Link

Regular Article | <u>Published: 02 November 2021</u> Is the European green deal achievable?

Samuel Furfari & Ernest Mund 🖂

The European Physical Journal Plus**136**, Article number: 1101 (2021)**108** Accesses**5** Altmetric<u>Metrics</u>





#### OPINION | COMMENTARY

# If You Want 'Renewable Energy,' Get Ready to Dig

Building one wind turbine requires 900 tons of steel, 2,500 tons of concrete and 45 tons of plastic.



By Mark P. Mills Aug. 5, 2019 6:48 pm ET



#### Strategic error: high dependence on critical materials for:

- Batteries
- Electric vehicles
- Photovoltaic solar panels
- Wind turbines (rotors)
- Electrolysers



Composite materials

Special materials





#### Concrete



## 16 MARCH 2023 COM(2023) 160 - Proposal for a regulation of the European Parliament and of the Council establishing a framework for ensuring a secure and sustainable supply of critical raw

materials



Materias primas fundamentales: garantizar unas cadenas de suministro seguras y sostenibles para el futuro ecológico y digital de la UE



John Haldane 4 fév. 1923, Cambridge Univ.



End of coal Wind turbines H<sub>2</sub>

J.S. HALDANE CH FRS 1860-1936 Physiologist lived and conducted experiments here 1891-1899

**J.B.S. Haldane**, in full **John Burdon Sanderson Haldane**, (born Nov. 5, 1892, <u>Oxford</u>, Oxfordshire, Eng.—died Dec. 1, 1964, Bhubaneswar, India), British geneticist, biometrician, physiologist, and popularizer of <u>science</u> who opened new paths of research in population <u>genetics</u> and <u>evolution</u>



#### Why is hydrogen mass-produced by methane transformation?



CH<sub>4</sub> + 2 H<sub>2</sub>0 → 4 H<sub>2</sub> + CO<sub>2</sub>  $\Delta$ H = - 164.7 kJ H<sub>2</sub>0 (I) → H<sub>2</sub> + ½ O<sub>2</sub>  $\Delta$ H = -285.8 kJ 4 x 285.8 = C O



 $\frac{4 x 285.8}{164.7} = 6.9$ 

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Note: This configuration is for a generic system and might not be representative of all existing manufacturers.

Based on IRENA analysis.



### Hydrogen, the inefficient green gas



The future of hydrogen will depend on **GEN IV** nuclear power. In the meantime, we will continue to produce it from **methane**, a highly valuable resource.





## Non renewables resources are limited

"The energy crisis has not yet overwhelmed us, but it will if we do not act quickly. [...] The most important thing about these proposals is that the alternative may be a national catastrophe. Further delay can affect our strength and our power as a nation. [...] The citizens who insist on driving large, unnecessarily powerful cars must expect to pay more for that luxury".

Jimmy Carter, "The President's Proposed Energy Policy." 18 April 1977. *Vital Speeches of the Day*, Vol. XXXXIII, No. 14, May 1, 1977, pp. 418-420.







## Resources and reserves

















 $\underset{\text{europe}}{\text{escp}} \rightarrow$ 

SAMUEL FURFARI - ESCP

## Which correlation?

**Oil Price vs Consumption** 





## United Nations Convention on the Law of the Sea



It gives coastal States rights they had not before







# The new Europe



http://farm8.staticflickr.com/7292/10134658063\_fca4fc3da2\_o.jpg







# Gas

# A sustainable key to understanding the geopolitics of energy



Samuel Furfari



#### LNG trade has overtaken pipeline trade







Samuel Furfari





Qatar is the world's 2nd largest exporter of liquefied natural gas (LNG) Reserves-production = 160 years of today exports







Samuel Furfari







Home / News and insights / Press releases / FPSO vessel for the bp-operated Greater Tortue Ahmeyim project successfully sets sail for project site

FPSO vessel for the bp-operated Greater Tortue Ahmeyim project successfully sets sail for project site

Release date: 23 January 2023



#### **Est Africa and gas potential**





Source : Jérôme Dyment, Institut de Physique du Globe de Paris, CNRS.

#### Zohr, a great success for ENI and Egypt

#### Dal 2025 non ci servirà più il gas russo, ce lo premette l'Eni

24 Settembre 2022 In Cronaca, Da non perdere



Discovered in August 2015 850 billion m<sup>3</sup>



Inaugurated in January 2018 BP and Rosneft partners

#### **TotalEnergies invests in Qatar and Iraq**

24 septembre 2022

## Le Qatar et TotalEnergies signent un contrat pour le développement d'un champ de gaz naturel





#### 27 milliards pour un siècle de Total en Irak

12 septembre 2021 par Jean-Pierre Filiu

C'est en Irak qu'a été lancée en 1924 la Compagnie française des pétroles, ancêtre de TotalEnergies, qui vient de signer avec Bagdad des contrats d'une valeur cumulée de 27 milliards de dollars.



Le PDG de TotalEnergies (à gauche) et le ministre irakien du Pétrole (à droite)

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## Germany as a gas hub in Northern Europe with the OPAL pipeline






111

111

Novatek CEO

Novatek's Yamal project a watershed moment for the country's hydrocarbon industry

HENRY FOY (+ Add to myFT)





Sign In

# How can LNG be exported from Yamal?





## **Electric vehicles? Why not, but on the condition of having electricity!**

#### Impact of electric vehicles on the electrical system for the electrification of 100% of the vehicle fleet

	Vehicles		Installed electricity		Future demand	
	millio n	km/a	Install ed capac ity GW	Gene ration TWh	Consu mptio n TWH	% of produ ction ón
Belgium	5,6	17 361	22,3	86,1	19	23 %
France	32,4	15 968	133,1	561,5	103	18 %
Spain	22,4	15 803	103,8	275,6	71	26 %
Italia	37,3	16 587	114,2	295,2	124	42 %
Poland	20,7	15 967	42,8	170,4	66	39 %
UE-27	253,5	15 000	948	2900	761	26 %
United Kingdom	32,5	11840	104,8	322,84	77	24%
USA	251	19 801	1117	4286,6	994	23 %
Japan	61,8	5163	306	950	64	7 %
	1					



https://blog.friendsofscience.org/2022/06/16/electric-vehicleswhy-not-but-on-condition-of-having-electricity/







W = F x d



# World oil demand by final use





Data: IEA Oct 2018, The futur of petrochemicals

## **Trends in global and EU CO2 emissions**

Samuel Furfari



Party to the UNFCCC	Increase since adoption of the UNFCCC
World	+59
Latin America	+73
Africa	+93
Non-OECD	+134
Pakistan	+245
Indonesia	+265
India	+280
China	+311
Vietnam	+1380
EU	-23

Data : BP 2022





### Our Mission

The Bureau of Energy Resources (ENR) leads the Department of State's efforts to develop and execute international energy policy through diplomatic and programmatic engagement that promote a low-emissions future, energy security for the United States and our allies and partners, and economic prosperity through sustainable, affordable, and reliable energy access.



SENIOR BUREAU OFFICIAL AND PRINCIPAL DEPUTY ASSISTANT SECRETARY

Harry Kamian

# Westinghouse signs initial contract for Ukrainian AP1000s

22 November 2021



SAMUEL

A contract signed by the Ukrainian nuclear operator Energoatom and US vendor Westinghouse will trigger the engineering and procurement of components for the first of several AP1000s planned for Ukraine. The country is planning as much as 11 GWe of new build by 2040.









## Sharm El Sheikh, 7 Nov. 2022



Presidente, yo lo voy a llamar, una vez esto pase.

Estamos tratando, pero me encantaría que pudiéramos hablar un poco más,

Bueno, hay que conseguir et camino (...).

residentes de Argentina y Colombia estarán en Paris en estos días.

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## **Coal** ≈ electricity



The Sydney Morning Herald

Scott Morrison backs coal wealth for decades to come



### Scott Morrison, not only nuclear submarin



### EU and India CO<sub>2</sub> emissions.

Data up to 2020 from BP Statistical Review 2023. After 2020, the trend towards zero carbon in the EU and linear increase in India (B), reaching EU per capita emissions in 2050 (A).







#ChamberNews #AEW2021

A Message from Nigerian Petroleum Minister on the future of the Oil and Gas Industry

1 443 vues • 17 sept. 2021

2 🖓 0 🖒 PARTAGER =+ ENREGISTRER ...

Mon, Nov 14, 2022

# Newsweek

# Europe's Failure to Meet Its Climate Goals Should Not Be Africa's Problem | Opinion

YOWERI K. MUSEVENI, PRESIDENT OF UGANDA ON 11/8/22 AT 7:00 AM EST

Russia-Ukraine War Not An 'Excuse' For 'Addiction' On Fossil Fuel: Al Gore

https://www.newsweek.com/europesfailure-meet-its-climate-goals-should-notafricas-problem-opinion-1757502





A Western Distraction from Climate Action

(f) 🕑 (in) 📎

Sustainability Now

0

May 30, 2023 | ALI RASHID AL NUAIMI

In a dangerous diversion, members of the US Congress and the European Parliament have demanded the removal of Sultan Al Jaber as COP28 president-designate. But to have any hope of taking urgent action to address climate change and maintain economic growth, the world must not let political drama impede tangible and practical solutions.

ABU DHABI – It should be common knowledge by now that climate change is a complex problem with outsize consequences for the Global South. By

Worse still, the US and European legislators are advocating international intervention in a sovereign decision – the latest in a long line of Western efforts to dictate to Global South governments for domestic political gain.



# Aramco, 12 July 2023, Kuala Lumpur

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#### Asia and the Energy Future

BY THE ARABIAN SUN / 0 COMMENTS / 12 JULY 2023

Aramco's president and CEO Amin Nasser calls on Asian leaders to speak louder and more clearly about the regions unique priorities to help shape a new, pragmatic global energy transition approach, as Aramco doubles down on its Asia commitments.



"The same energy transition policies should not be applied to every nation. If they are, it will severely affect the competitiveness of those who are not at the same economic maturity level, which is the case for many in Asia."

"So, in a century that is Asian, we know our future is Asia."

— Amin Nasser



https://aramcoexpats.com/articles/asia-and-the-energy-future/

# **Processes to eliminate CO<sub>2</sub> in combustion**

	Post-combustion	Oxy-combustion	<b>Pre-Combustion</b>		
C	leaning of a large volume of flue gas	Cleaning of a small volume of flue gas	Elimination of CO <sub>2</sub> before combustion		
	Air (79% N <sub>2</sub> ) Combusti on in air Capturing CO <sub>2</sub> in fumes (with amines)	Air separation (elimination of N <sub>2</sub> ) Oxygen Combustion in pure O <sub>2</sub>	Water Gasification of coal Syngas (CO + H <sub>2</sub> ) Conversion of		
ESCP EUROPE BUSINESS SCHOOL Samuel Furfari	CO <sub>2</sub>	Capturing fumes containing only water & CO <sub>2</sub>	Combustion of H <sub>2</sub>		

# Using the CO<sub>2</sub>?

## **Oxydation (Combustion) of methane:**

 $CH_4 + 2O_2 \rightarrow 2H_2O + CO_2$  △H° = - 802,88 kJ à 25° C

# **Reduction of CO<sub>2</sub> in methane**

- 2 x (2 H<sub>2</sub>O (gas) → 2 H<sub>2</sub> + O<sub>2</sub>)  $\Delta H^{\circ} = 2 \times 483,88 = 967,76$  kJ à 25°C
- $4 H_2 + CO_2 \rightarrow CH_4 + 2H_2O$  (gas) ΔH° = -164,88 kJà 25°C
- <u>Global reaction</u> :

 $2 H_2 O + CO_2 \rightarrow CH_4 + 2 O_2 \Delta H^\circ = \frac{802,88 \text{ kJ}}{25^\circ \text{C}}$ 

Overall it is necessary to provide 802.88 kJ per mol of CH<sub>4</sub> formed (16 g) hence 50,180 kJ/kg CH<sub>4</sub>

# **Reduction of CO<sub>2</sub> in methanol (with water as a source of hydrogen)**

**3** x [2 H<sub>2</sub>O (gas) → 2 H<sub>2</sub> + O<sub>2</sub>]  $\Delta$ H° = 3 x 483,88 = 1451,64 kJ à 25°C 2 x [3 H<sub>2</sub> + CO<sub>2</sub> → CH<sub>3</sub>OH + H<sub>2</sub>O (gas)]  $\Delta$ H° = 2 x (- 87,02) = -174,04 kJ à 25°C

#### **Global reaction:**



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**4 H<sub>2</sub>O + 2 CO<sub>2</sub> → 2 CH<sub>3</sub>OH + 3 O<sub>2.</sub>** ΔH° =  $\frac{1277,6 \text{ kJ}}{1277,6 \text{ kJ}}$ à 25° C

Overall it is necessary to provide 638.8 kJ per mol of CH<sub>3</sub>OH formed or per mol of CO<sub>2</sub> transformed (it is less than for CH<sub>4</sub> production because carbon is less strongly

## CO<sub>2</sub> : life exhaust pipe





JEAN-PAUL OURY : "TOUS LES PROBLÈMES VIENNENT D'UNE LACUNE CRUELLE QUI EST L'ABSENCE D'UNE POLITIQUE SCIENTIFIQUE ALTERNATIVE À L'ÉCOLOGISME." All the problems stem from a cruel shortcoming, which is the absence of an alternative scientific policy to ecologism.

Jean-Paul Oury

# Greta a tué Einstein





# sfurfari@escp.eu

#### The changing world of energy and the geopolitical challenges

1. Understanding energy developments



The changing world of energy and the geopolitical challenges 2. Shifting Sands: The Geopolitics of Energy





# **Energy insecurity**

The organised destruction of the EU's competitiveness

