

EXPLORATION OF FUSION POWER PENETRATION UNDER DIFFERENT GLOBAL ENERGY SCENARIOS USING THE EFDA TIMES ENERGY OPTIMISATION MODEL

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INTRODUCTION

The first commercial fusion power plants are expected to start operating from 2050. How the global energy system will be as for that time nobody knows, but future can be explored by means of scenarios. Which other electricity generation technologies will be available in the long term and what the role of fusion in the system will be will depend on environmental and socioeconomic factors which are unknown at present but can be approached constructing representations of possible futures

METHODOLOGY

The EFDA Times model (ETM) is a global optimization energy model developed within the framework of the Socio Economic Research of Fusion project (SERF) in EFDA. ETM uses the TIMES model generator provided by IEA-ETSAP TCP (IEA Energy Technology Systems Analysis Programme, Technology Collaboration Partnership). The main aim of ETM is to analyse the introduction and development of fusion technologies in the future global energy system

STORYLINES

Storyline	Description
Harmony	- Strong environmental responsibility - Operators take a long-term view when deciding their investments - Very stringent global carbon emissions target and all regions cooperate
Paternalism	- Mixed environmental responsibility - Operators take a medium-term view when deciding their investments - Very stringent global carbon emissions target and all regions cooperate
Fragmentation	- Weak environmental responsibility - Operators take a short-term view when deciding their investments - Flexible global carbon emissions target and not all regions cooperate

Table 1. Storylines

FUSION POWER PLANTS

Plant	Date	Specific capital (\$ ₂₀₀₅ /kW)	Efficiency (%)	FIXOM (M\$ ₂₀₀₅ /GWa)	VAROM (M\$ ₂₀₀₅ /PJ)
Basic	2050	5910	42	65.8	2.16
	2060	4425	42	65.8	1.64
Advanced	2070	4220	60	65.3	2.14
	2080	3255	60	65.3	1.64

Table 2. Fusion power plants in the model

SCENARIOS

Scenario	Fusion invest costs	Fusion availability
PATERNALISM	Base (Table 2)	Yes
+30%InvCosts	+30% Base	Yes
-30%InvCosts	-30% Base	Yes
No Availability	-	No

Table 3. Scenarios

RESULTS

- Fusion technologies participation in the global electricity system by 2100 goes from 10% to 14% depending on the scenario. Stringent environmental targets are key for the penetration and development of fusion technologies (Fig.1)
- When fusion is not available, most of the electricity production in 2100 comes from renewable (68% share) and CCS (19% share) technologies. Fusion technologies are mainly replaced by CCS and fission technologies whose production grows 42% and 37% respectively regarding the Paternalism scenario (Fig. 2)
- Fusion penetration is very sensitive to investment cost variations going from 13% to 42% when investment costs are 30% lower than in the Paternalism case and from 13% to 1% when those costs are 30% higher (Fig. 3)
- The global rate of fusion technologies growth is 12% per year from 2070 to 2100 (Fig. 4)

<https://www.euro-fusion.org/collaborators/socio-economics/>

Figure 1. FUSION PENETRATION IN THE GLOBAL ELECTRICITY SYSTEM

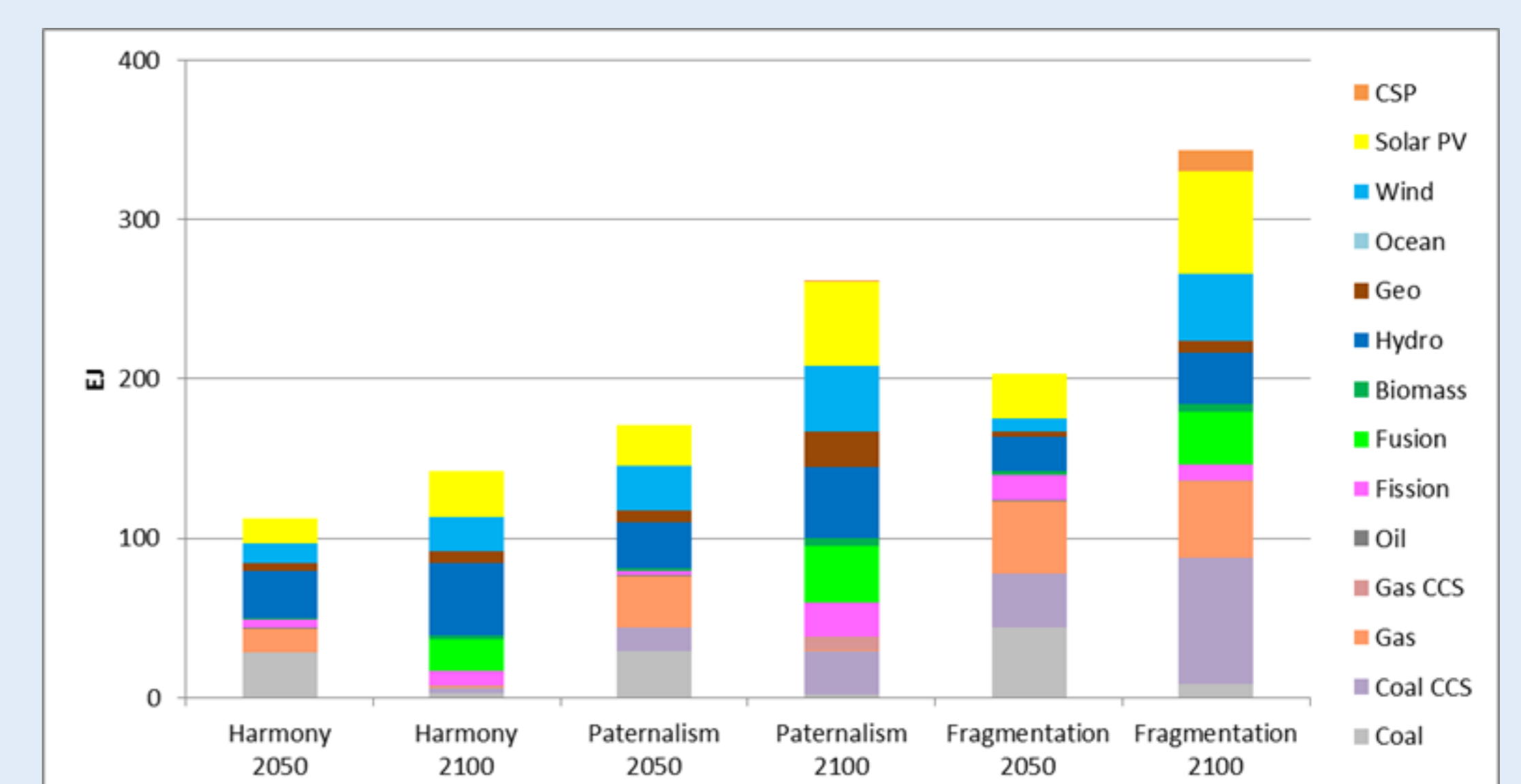


Figure 2. NO FUSION AVAILABILITY

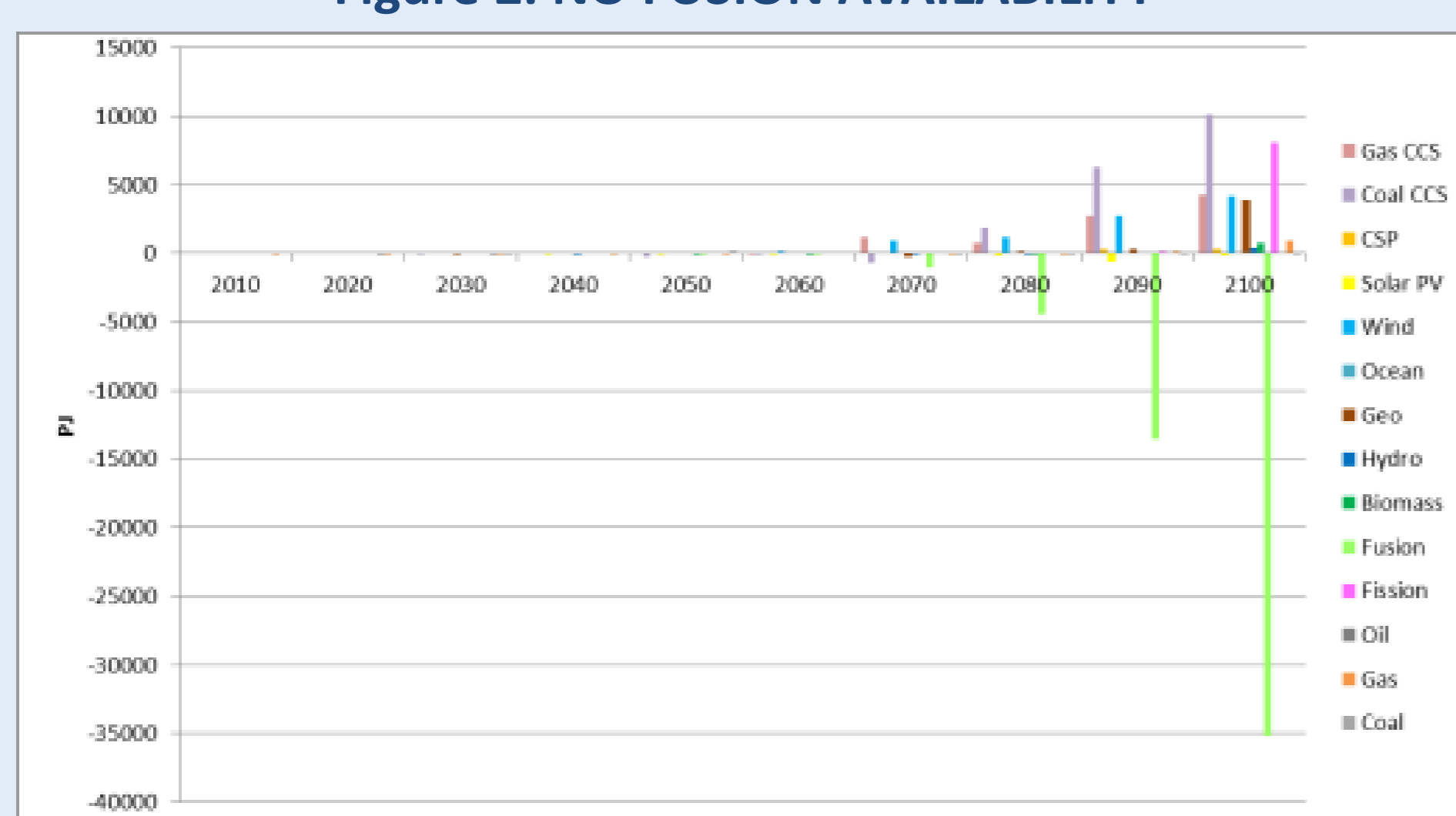


Figure 3. SENSITIVITY ANALYSIS

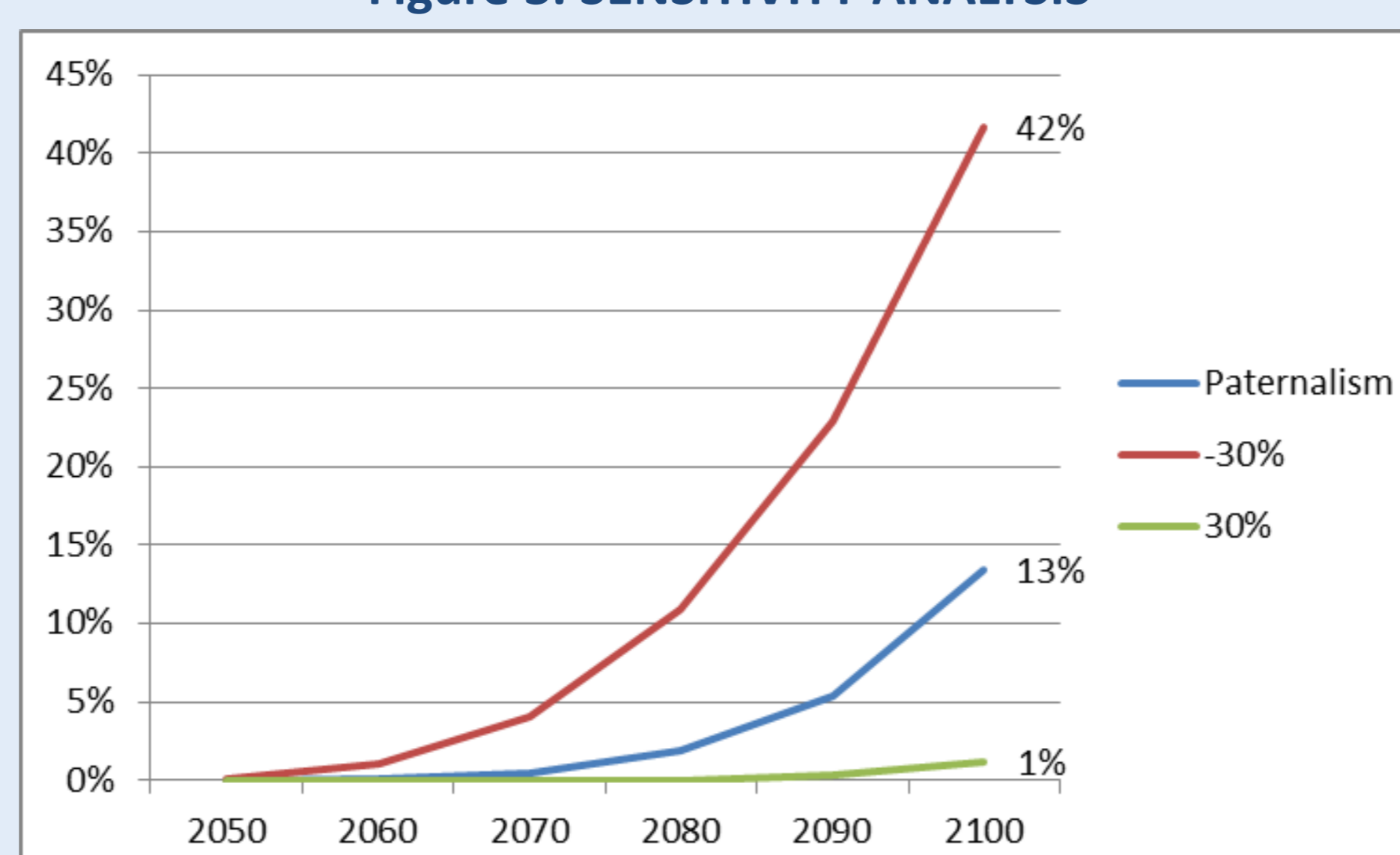
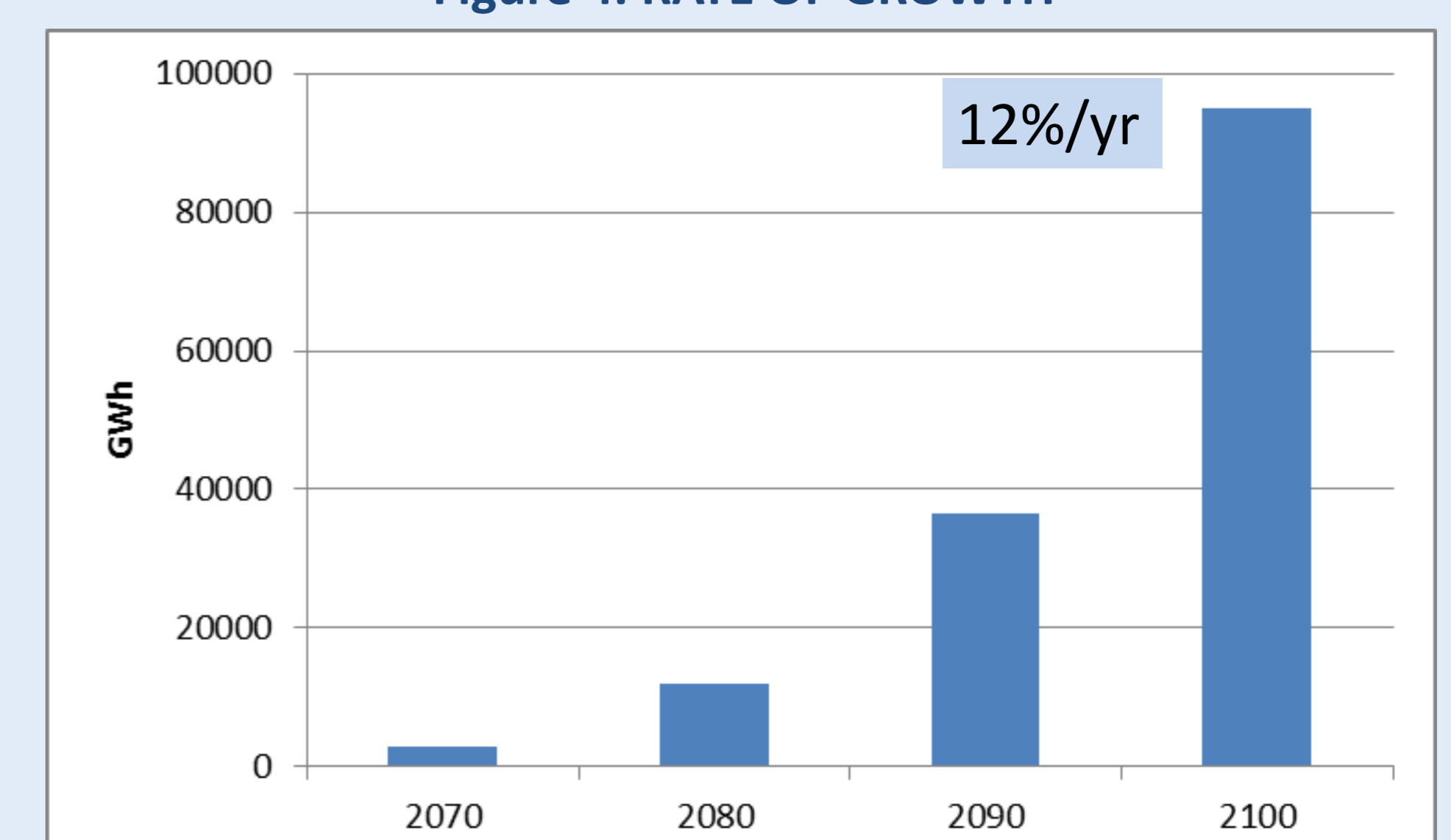


Figure 4. RATE OF GROWTH



CONCLUSIONS

In a world with a strong environmental responsibility and a stringent global carbon emissions target, fusion technologies contribute, together with renewable technologies, and in a minor proportion, CCS technologies to achieve almost decarbonised global electricity system



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