



Issues of Secure Energy Supply under Environmental constraints

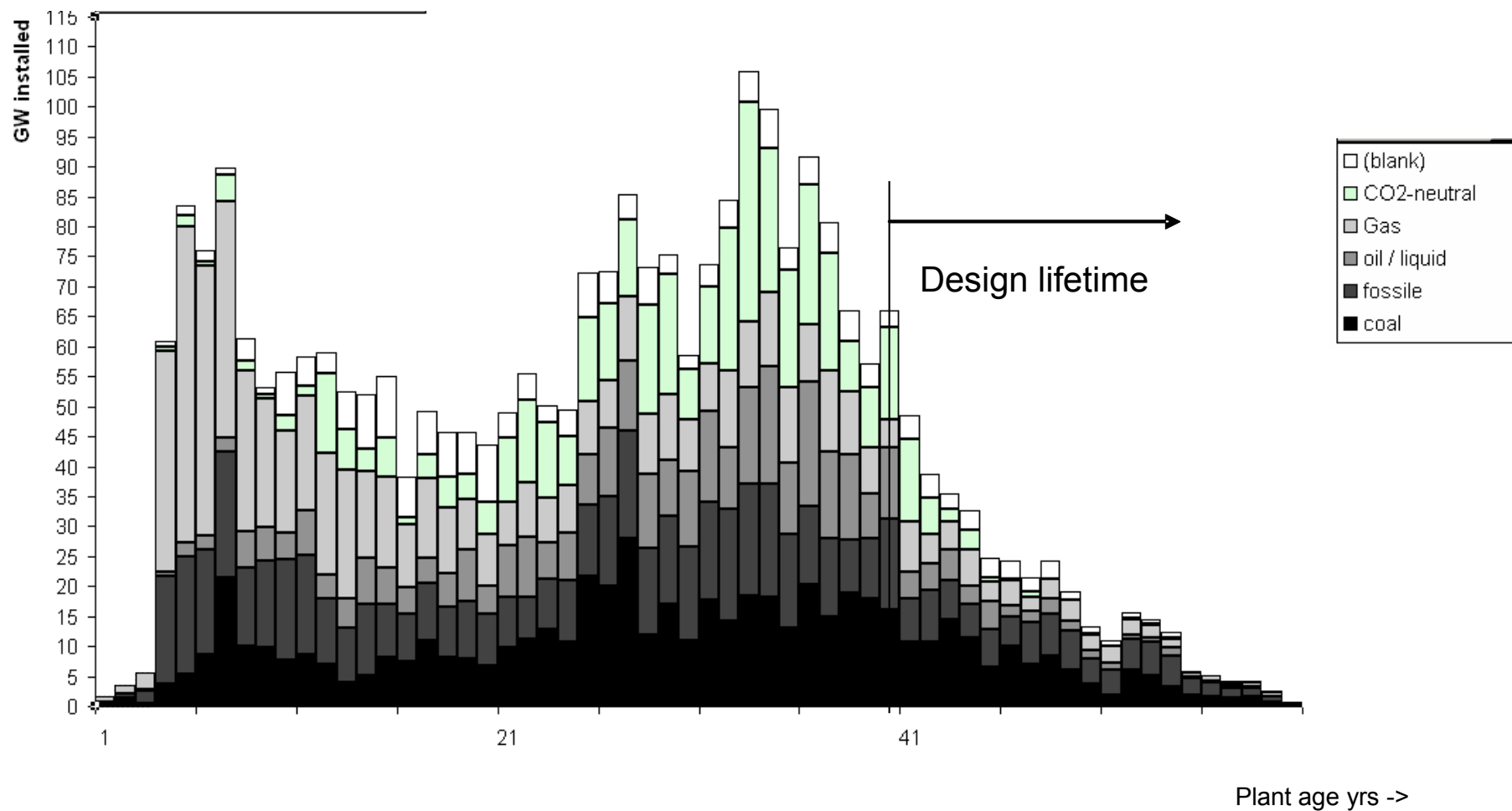
Wolfgang Kröger, ETH Zürich and IRGC Geneva

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WG 1. „Investment Requirements“

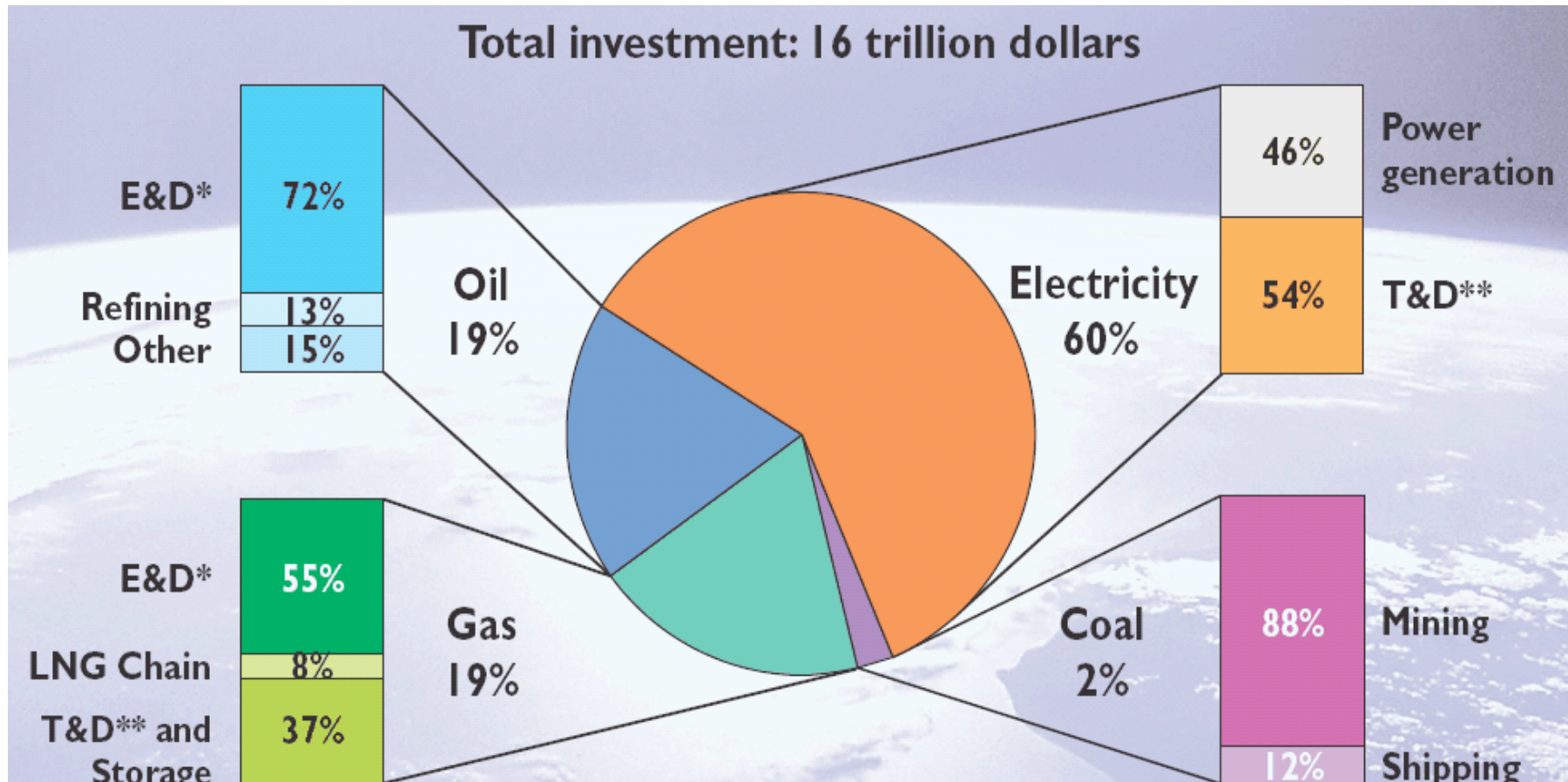


Global Installed Capacity versus Plant Age



source: ALSTOM

Worldwide Investment Needs in the Energy Sector until 2030 (EU25: 695 bill € in electricity sector)



16 trillion (10¹²) \$ translate to 1% of projected GDP

* E&D: exploration & development

** T&D: transmission & distribution

source: IEA Outlook, 2005

Electric Power Supply Systems: Recent Major Blackouts

Blackout	Loss of lo [GW]	Duration [h]	People affected	Main causes	Cascading
Aug. 14 2003 Great Lakes, NY	~ 60	~ 16	50 Mio	Inadequate right-of-way maintenance, EMS failure, poor coordination among neighboring TSOs	X
Aug. 28 2003 London	0,72	1	500'000	Incorrect line protection device setting	
Sept. 23 2003 Denmark / Sweden	6,4	~ 7	4,2 Mio.	Two independent component failures (not covered by N+1 rule)	
Sept. 28 2003 Italy	~ 30	up to 18	56 Mio.	High load flow CH, line flashovers, poor coordination among neighboring TSOs	X
July 12, 2004 Athens	~ 9	~ 3	5 Mio.	Voltage collapse	
May 25, 2005 Moscow	2,5	~ 4	4 Mio	Transformer fire, high demand leading to overload conditions	
June 22 2005 Switzerland (railway supply)	0.2	~ 3	200'000 passengers	Non-fulfillment of the N rule, wrong documentation of line protection settings, inadequate alarm processing	
Aug. 14 2006 Tokyo	?	~ 5	0.8 Mio households	Damage of a main line due to construction work	
Nov. 4, 2006 Western Europe ("controlled" load shedding)	~ 14	~ 2	15 Mio. households	High load flow ENL, violation of the N rule, poor inter TSO coordination	X

source: Kröger and Schläpfer, 2007

IRGC Risk Governance Framework

