



February 2001

# CAME - GT Workshop

## WP 6 - RTD Strategy

Dr. Peter Holmes

**ALSTOM**

# Work Package 6 - Research & Technology Development Strategy

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## Objective;

Assess international progress, define and update the RTD strategy and objectives as required and produce proposals for future programmes for discussion

## Tasks;

- Produce overview of the developments in each cluster and produce annual reports for the management group
- Identify technology gaps and key issues for the future
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## Deliverables;

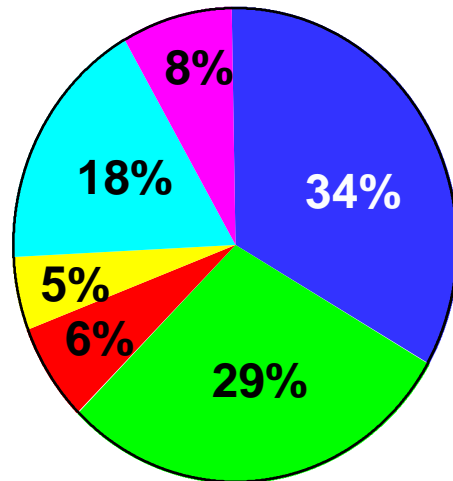
- Overview report (cluster progress v international progress)
- Six monthly reports to management group
- Reviews at cluster and conference meetings

# World Installed Capacity by Region & Technology



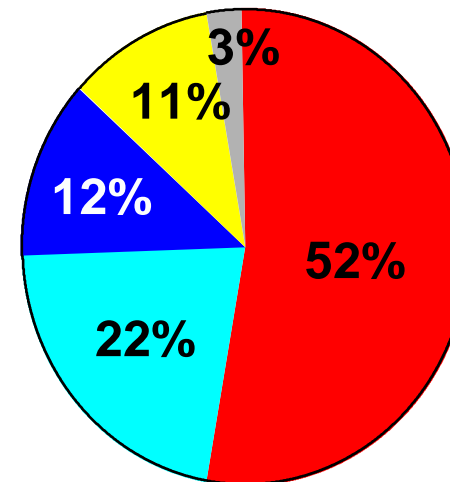
**Total World-wide Installed Capacity in 1999: ~ 3'350 GW**

**Capacity by Region**



- Europe
- North America
- Middle East & Africa
- South & Central America
- Asia Pacific (excl. China)
- China

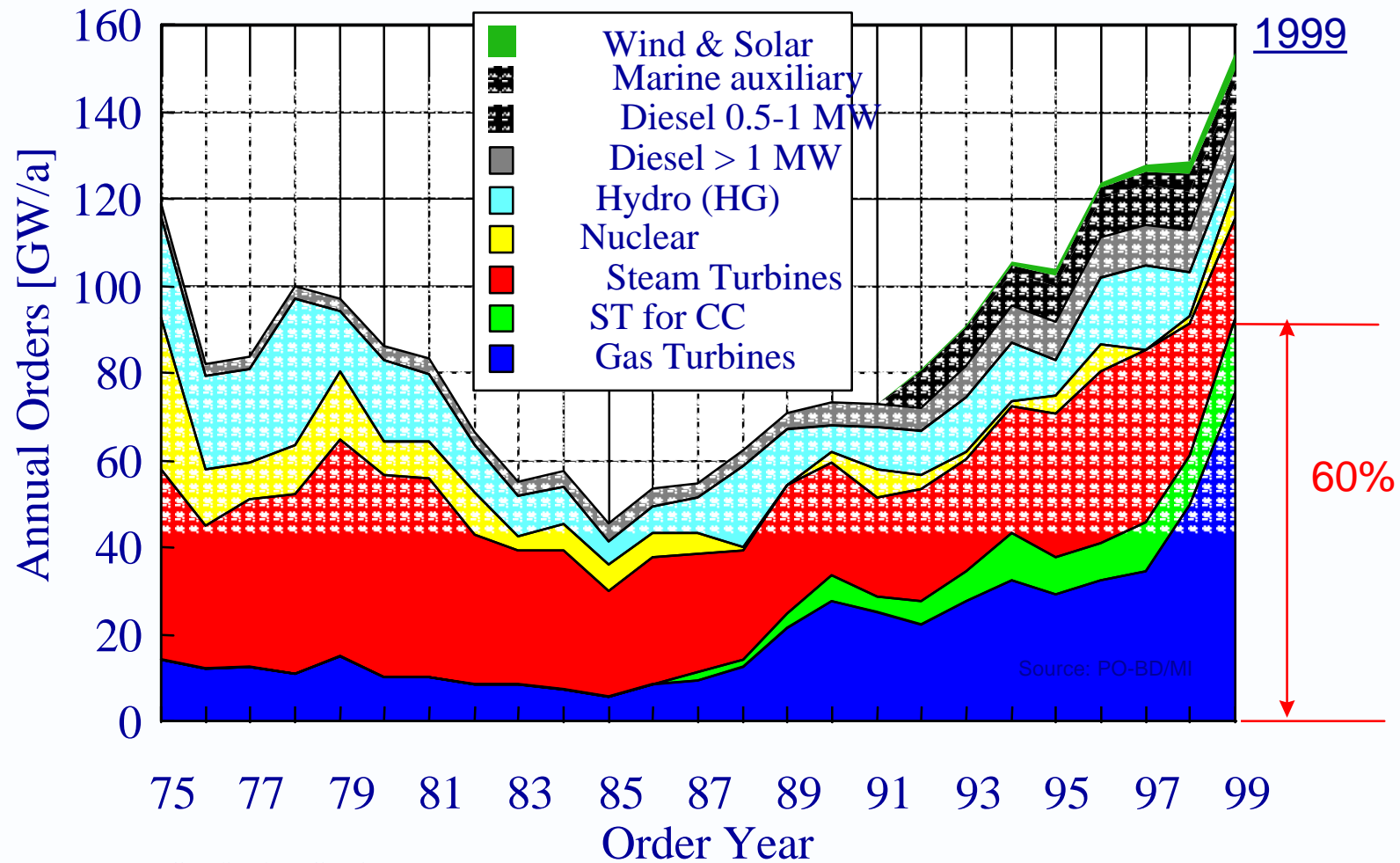
**Capacity by Technology**



- Conventional Steam Turbines
- Hydro Plants
- Gas Turbines (incl. CC)
- Nuclear Plants
- Diesel Engines

Source: PO-BD/MI, UDI

# Gas Turbine Based Power Generation Represents 60% of New Market



Note: - GT, ST & HG > 3 MW

Sources: PO-BD/MI, Diesel & Gas Turbine World-Wide

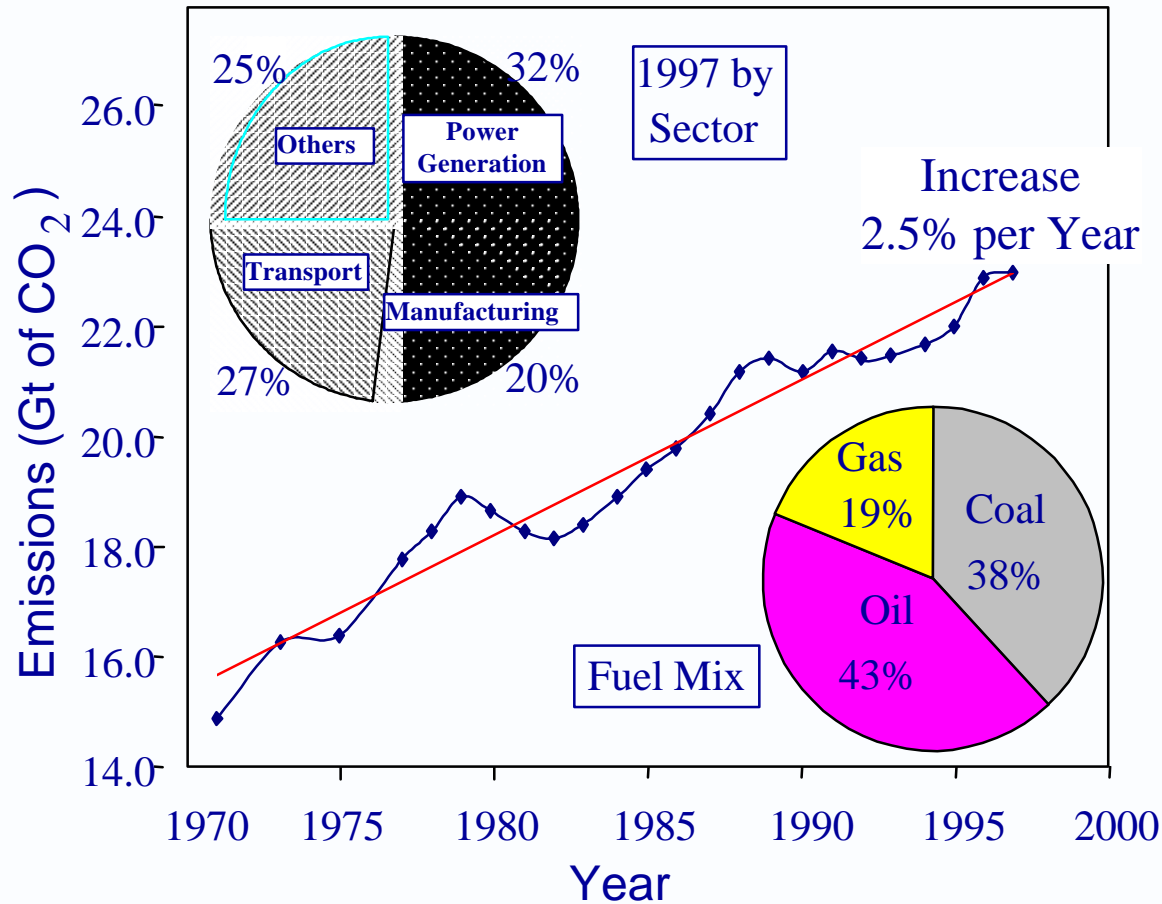
In open markets new Gas Power will dominate,  
where gas is available

- - USA - 360 GW 2000 to 2020
    - ⇒ 88% gas based
    - ⇒ 9% coal based
    - ⇒ 3% renewables

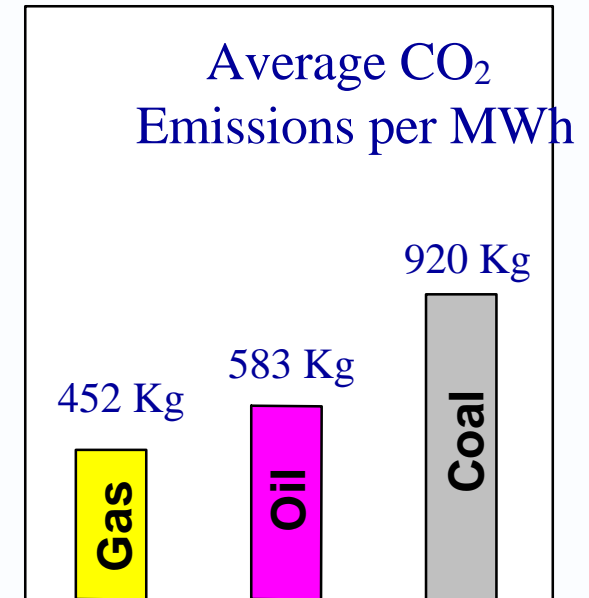
(US Energy Administration report)
  - Europe - Gas Power 2000 to 2005
    - ⇒ ~12 GW in controlled market
    - ⇒ ~ 35 GW in open market

(Cambridge Energy Research Associates)

# World CO<sub>2</sub> Emissions are increasing by ~2.5% per year



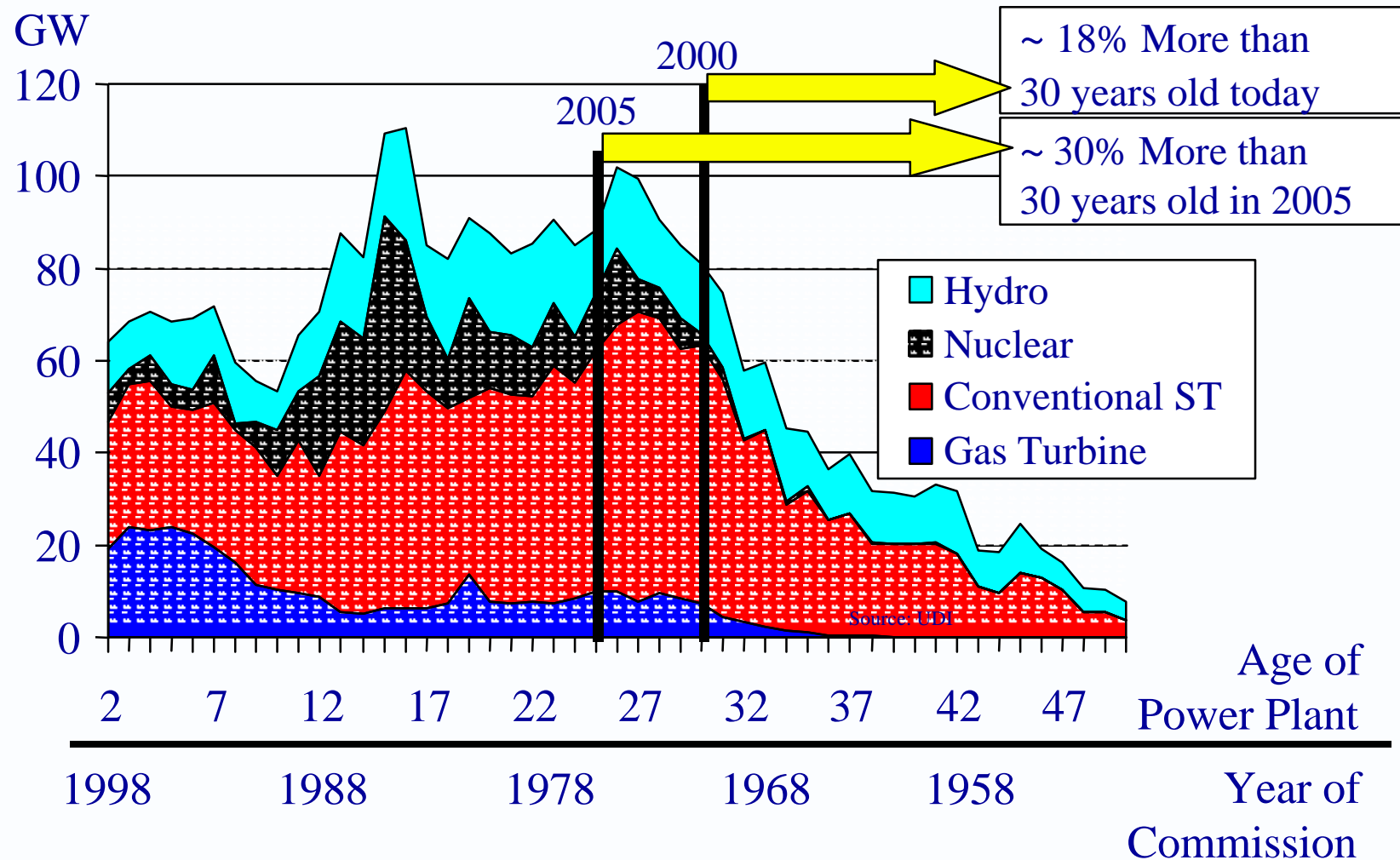
## Fuel Effects in Power Generation



Replacing old coal fired plant with gas will reduce emissions

# World Installed Capacity by Age

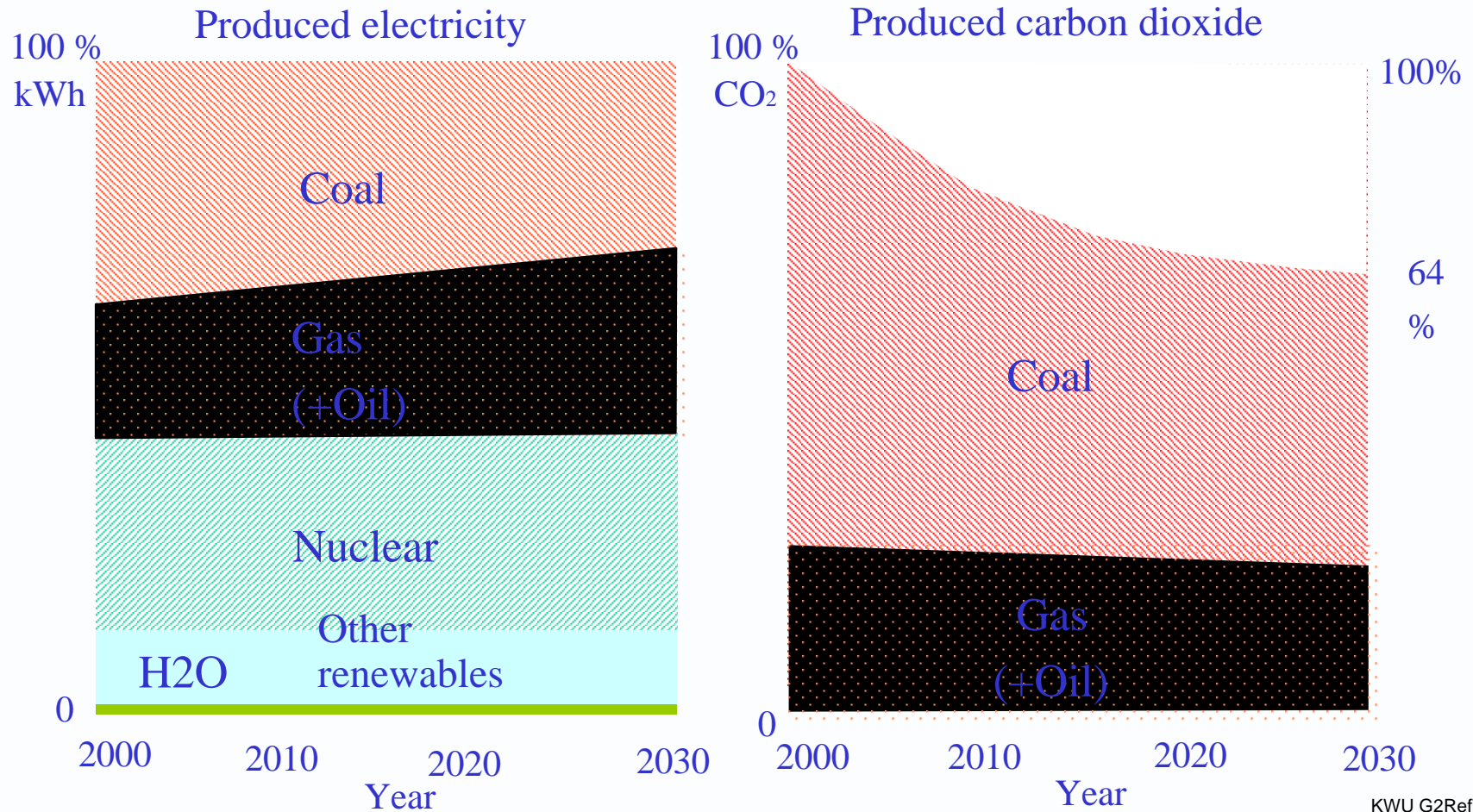
## Installed Capacity is Aging Rapidly



# Scenario 1 - Replacing old power plant



Old fossil fuel plant replaced 50/50 with high efficiency new gas & coal plant can give 36% reduction in CO<sub>2</sub>



KWU G2RefT  
St/DrBe/FoI/  
Scenario2508



# US Challenge in Gas Turbine Technology



- US Technology Dominates World GT

Market	1994	1999	Trend
<20MW	~ 60%	> 75%	↗
>50MW	~ 35%	> 70%	↗

- Public funding: DoE, Civil & Military areas:

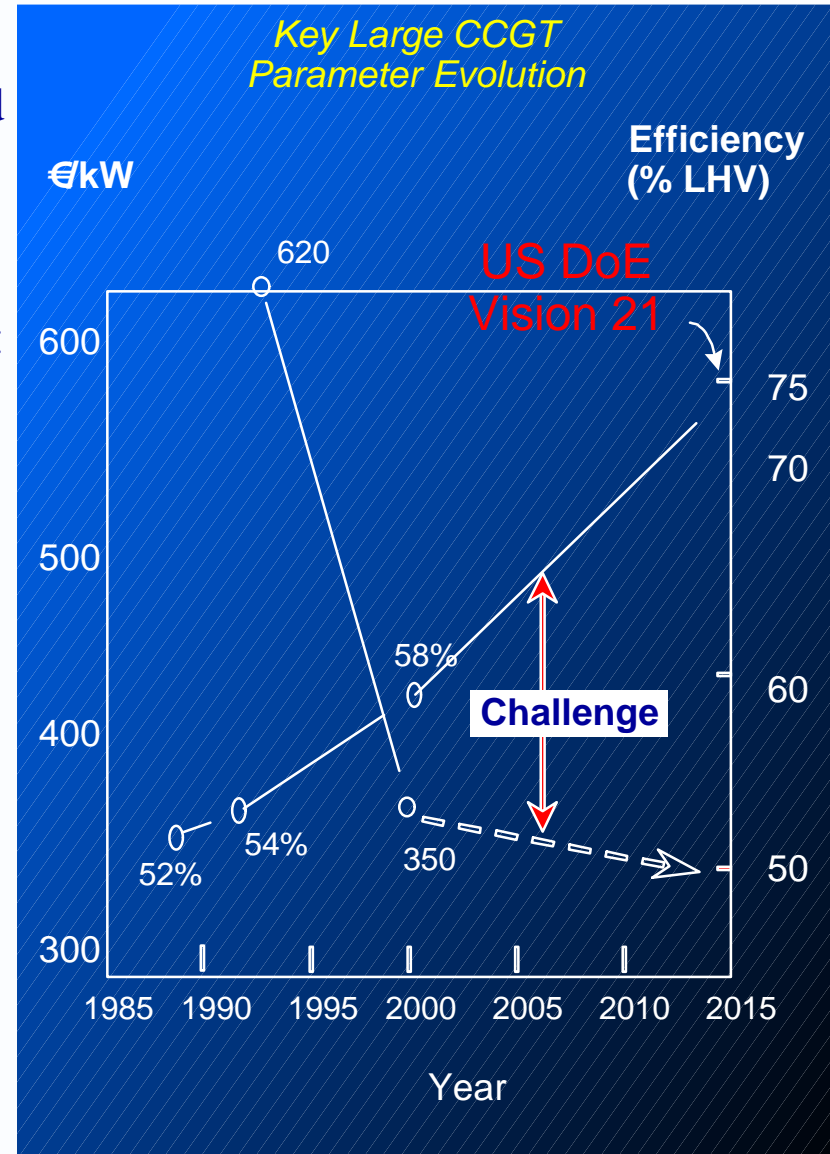
per year

DoE (ATS,NGTS,V21)	~ 45 M US\$
California (Cycles)	~ 60 M US\$
DoD (IHPTET)	~170 M US\$
NASA (propulsion)	~ 50 M US\$

- Prototypes funded by DoE

Solar Mercury	~150 M US\$
GEPS H-Technology	~250 M US\$
West-house H-Tech	~180 M US\$

**Sustained US Government Support**



- **Rescue and build a competitive Energy Industry in Europe**
  - as a key element of European economy and industry
  - create wealth/jobs through EU and export potential
  - significantly contribute to environmental policy targets and attainment of Kyoto/GCC targets - national / EU / global
- **Establish a Gas Turbine program with critical mass**
  - the Gas Turbine is a key part of Energy Industry for 21st Century
  - foster technical excellence with integrated academic support
  - integrate national and pan-European initiatives
  - improve industry/research networks and partnerships
- **Technology **and** Prototype Demonstration**
  - develop robust technology for reliable application
  - validate technology with prototypes for real transfer to the market place

- Next 5 to 10 Years

- Cost driven market, meeting environmental regulations

- developing mosaic of power systems to achieve security of supply
- continued electrification of the third world at lowest cost (↓ CO<sub>2</sub>)
- deregulation and growth of merchant plant (gas when available)
- decentralization, co-generation and industrial integration
- clean coal and opportunity fuel systems (zero cost fuel)
- growth of cost effective re-newables and energy storage systems

- Technical drivers

- availability and flexibility at peak efficiency (⇒ greatest profit)
- efficiency with reliability giving lowest cost of electricity
- emissions control needed to meet regulation

- Next 10 to 30 Years

- Environmental driven market at minimum cost

- economically driven CO<sub>2</sub> market
- increasing dominance of cost effective re-newable energy
- integrated energy storage systems
- CO<sub>2</sub> capture and sequestration required for Fossil energy
- maintain mosaic of power generation for security of supply

- Technical drivers

- Ultra high efficiency and low emission GT
- Fuel flexibility including coal and bio-mass
- compatibility with zero emissions power plant (including water)
- integrated power and transport fuel plant

## Short Term Customer Drivers



- Improved RAM (RAM costs come out of profit)
  - Reduce life cycle costs, improve reliability, availability and maintainability
    - only validated technology introduction
    - improved instrumentation and monitoring
    - life debit based on operating conditions
    - condition based maintenance
    - expert based health monitoring systems
  
- Optimized profit Opportunity
  - Flexible operation at optimum efficiency
    - power augmentation to meet price peaks
    - high efficiency at part load to allow load following
    - fuel flexibility to take advantage of price changes

## Objectives

- Reduce life cycle costs by  $>15\%$  & improve RAM
- Develop ultra clean, high performance turbines for gas and for coal and bio-mass in the long term
- Develop cross cutting technologies
  - Advanced materials, combustion systems, computational tools, controls and instrumentation
    - SX for 80% yield, low S alloy casting process, SX welding
    - Turbulent combustion models, unstable combustion, robust fuel flexible designs, catalytic and trapped vortex concepts
    - Whole engine simulation, IT platform for RAM, transient simulation, CFD validation
    - Feedback controls, sensor tests, on-line lifing

## DOE Office of Fossil Energy Resource Requirements (\$ Million)

	2001	2002	2003	2004	2005	2006	2007	2008	SUM
<b>RAM Improvement</b>	2	2	9	14	18	14	9	7	75
<b>System Development</b>	25	31	35	36	32	30	20	15	224
<b>Crosscutting Technology</b>	16	20	20	20	16	12	10	10	124
<b>Total Program</b>	43	53	64	70	66	56	39	32	423

2000 - 2005

- RAM improvement, NGT concept, component tests

2005 - 2010

- Condition monitoring, Hybrid  $\eta=70\%$  demonstration

2010 - 2015

- NGT integrated into zero emission solid fuel plant