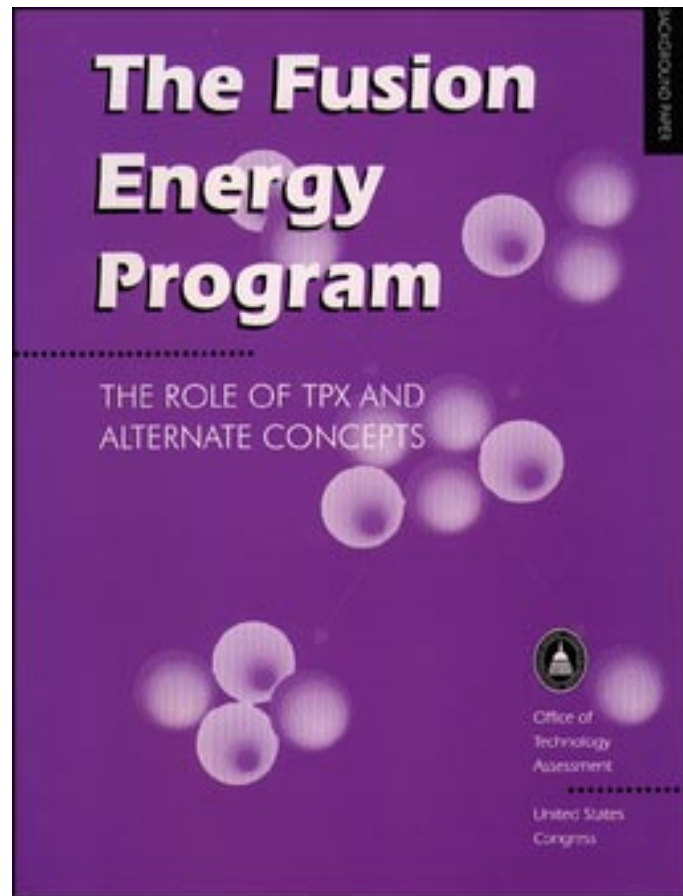


*The Fusion Energy Program: The Role of
TPX and Alternate Concepts*

February 1995

OTA-BP-ETI-141

GPO stock #052-003-01403-3



Recommended Citation: U.S. Congress, Office of Technology Assessment, *The Fusion Energy Program: The Role of TPX and Alternate Concepts*, OTA-BP-ETI-141 (Washington, DC: U.S. Government Printing Office, February 1995).

Foreword

For over four decades the federal government has supported research to develop reactors that harness fusion energy for commercial electric power production. However, even the most optimistic proponents of the U.S. Department of Energy's fusion energy program note that many scientific, engineering, and economic challenges remain. Meeting these challenges sufficiently to construct a prototype commercial fusion powerplant is expected to require tens of billions of dollars in experimental facilities and research over the next several decades.

This background paper, responding to a request by the House Committee on Science, focuses on the following two questions for the U.S. fusion energy program. First, what is the role of the Tokamak Physics Experiment (TPX), an approximately \$700 million fusion reactor currently awaiting a congressional decision to begin construction? This paper examines the history of TPX planning; the anticipated scientific, engineering, and institutional contributions; and the relationship between the TPX and the next major planned tokamak facilities, the International Thermonuclear Experimental Reactor (ITER), currently in the design stage, and the DEMO facility planned for operation in about three decades, which would be the first fusion device to demonstrate production of electricity.

Second, what is the role of alternatives to the tokamak concept in a broad-based fusion energy program? Over the past several years the program has been narrowed substantially to concentrate on the single most successful and furthest developed fusion energy concept, the tokamak. This narrowing, driven heavily by budgetary reasons, has been decried by many fusion researchers as premature given the current elementary state of fusion knowledge. This study examines the motives for pursuing alternate concepts, the steps involved and costs of alternate concept research, and the current status of alternate concept research as conducted in the U.S. fusion energy program.

While the focus of the study is on the TPX and alternate concepts, it also provides a history of the overall fusion energy program. With this context, the study identifies (but does not answer) some underlying questions that must be addressed. The most pressing of these are: what is the potential role of the fusion energy program in meeting long-term energy needs? what level of research funding is justified by that role? and what are the most reasonable goals and directions for the program under scenarios of flat or declining budgets?

OTA received generous assistance from workshop participants, reviewers, and others who offered valuable information and comments in the course of this study. To all of them goes the gratitude of OTA and the personal thanks of the project staff.



ROGER C. HERDMAN
Director

Workshop

Alan Crane, *Chairman*

Senior Associate
Energy, Transportation, and
Infrastructure Program
Office of Technology Assessment

Donald Correll

Deputy Program Leader for
Inertial Confinement Fusion
Lawrence Livermore National
Laboratory

David H. Crandall

Director, Applied Plasma Physics
Division
Office of Energy Research
U.S. Department of Energy

N. Anne Davies

Associate Director for Fusion
Energy
Office of Energy Research
U.S. Department of Energy

Stephen O. Dean

President
Fusion Power Associates

Robert Hirsch

Consultant

Alan Hoffman

Aerospace and Energetics
Research Building
University of Washington, Seattle

Jack Kaslow

Executive Director, Northeast
Region
Electric Power Research Institute

William D. Kay

Department of Political Sciences
Northeastern University

Dale M. Meade

Deputy Director
Princeton University
Plasma Physics Laboratory

David O. Overskei

Senior Vice President
General Atomics

John Perkins

Physicist and Group Leader
Lawrence Livermore National
Laboratory

Stewart C. Prager

President, University Fusion
Association and Professor
Department of Physics
University of Wisconsin-Madison

Paul-Henri Rebut

International Thermonuclear
Experimental Reactor
Engineering Design Activities

John Sheffield

Fusion Energy Division
Oak Ridge National Laboratory

John W. Willis

Director, Confinement Systems
Division
Office of Energy Research
U.S. Department of Energy

Note: OTA appreciates and is grateful for the valuable assistance and thoughtful critiques provided by the workshop participants. The participants do not, however, necessarily approve, disapprove, or endorse this report. OTA assumes full responsibility for the report and the accuracy of its contents.

Project Staff

Peter D. Blair

Assistant Director
Industry, Commerce, and
International Security Division

Emilia L. Govan

Program Director
Energy, Transportation, and
Infrastructure Program

ADMINISTRATIVE STAFF**Marsha Fenn**

Office Administrator

Tina Aikens

Administrative Secretary

Gay Jackson

PC Specialist

Lillian Chapman

Division Administrator

PRINCIPAL STAFF**Robin Roy**

Project Director

Karen Larsen

Senior Analyst

Richard Rowberg

Senior Specialist
Congressional Research Service

PUBLISHING STAFF**Mary Lou Higgs**

Manager

Dorinda Edmondson

Typographer

Susan Hoffmeyer

Graphic Designer

Chip Moore

Production Editor

Chris Onrubia

Senior Graphic Designer

Reviewers and Contributors

Anna Aurilio

U.S. Public Interest Research
Group

Charles Baker

University of California,
San Diego

David E. Baldwin

Lawrence Livermore National
Laboratory

Roger Bangerter

University of California, Berkeley

Richard Brody

Office of Technology Assessment

Mark Brown

Office of Technology Assessment

E. Michael Campbell

Lawrence Livermore National
Laboratory

Valeriy Chuyanov

International Thermonuclear
Experimental Reactor
Engineering Design Activities

Thomas Cochran

Natural Resources Defense
Council

Tony Colleraine

General Atomics

Donald Correll

Lawrence Livermore National
Laboratory

David H. Crandall

U.S. Department of Energy

N. Anne Davies

U.S. Department of Energy

Stephen O. Dean

Fusion Power Associates

James F. Decker

U.S. Department of Energy

Gerald Epstein

Office of Technology Assessment

Julie Van Fleet

International Thermonuclear
Experimental Reactor
Engineering Design Activities

Robert Goldston

Princeton Plasma Physics
Laboratory

Robert Hirsch

Consultant

Alan Hoffman

Oak Ridge National Laboratory

Rush D. Holt

Princeton Plasma Physics
Laboratory

Paul Komor

Office of Technology Assessment

Grant Logan

Lawrence Livermore National
Laboratory

Bogdan C. Maglich

Advanced Physics Corp.

Dale M. Meade

Princeton Plasma Physics
Laboratory

David O. Overskei

General Atomics

John Perkins

Lawrence Livermore National
Laboratory

Stewart Prager

University Fusion Association
University of Wisconsin, Madison

Paul-Henri Rebut

International Thermonuclear
Experimental Reactor
Engineering Design Activities

Michael Roberts

U.S. Department of Energy

Marshall N. Rosenbluth
International Thermonuclear
Experimental Reactor
Engineering Design Activities

Norman Rostoker
Department of Physics
University of California, Irvine

Joanne Sedor
Office of Technology Assessment

John Sheffield
Oak Ridge National Laboratory

Yasuo Shimomura
International Thermonuclear
Experimental Reactor
Engineering Design Activities

Loren Steinhaur
Redmond Plasma Physics
Laboratories
University of Washington

Ravi Sudan
Laboratory of Plasma Studies
Cornell University

Matthew Weinberg
Office of Technology Assessment

John W. Willis
U.S. Department of Energy

Note: OTA appreciates and is grateful for the valuable assistance and thoughtful critiques provided by the reviewers. The reviewers do not, however, necessarily approve, disapprove, or endorse this report. OTA assumes full responsibility for the report and the accuracy of its contents.