

*Islamic Republic of Iran*  
*Iran Ministry of Energy*

*National Strategy of Iran Fuel Cell*  
*Technology Development*

*Fuel Cell Development council*  
*The secretariat of fuel cell steering committee*

## *In the Name of God*

With reference to the ninth clause of the general policies of the fourth plan of Islamic Republic of Iran for economic, social, and cultural development, and regarding the suggestion of fuel cell steering committee<sup>1</sup>, this document is presented to promote systematic development of fuel cell technology in Iran. This document is provided based on "feasibility studies - analyzing the fuel cell attraction, and formulating the strategy of its technology development in Iran" – and it is considered as the up-stream document for all of the division and supra-division plans in this technological area.

### *Abbreviations*

In this document, "feasibility studies - analyzing the fuel cell attraction, and formulation the development strategy of its technology in Iran conducted by Fuel Cell Steering Committee for two years, is briefly called "Basic Studies".

### *1- Introduction*

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<sup>1</sup> members of this committee are Energy Deputy of Iran ministry of Energy, Technology Cooperation Office of Presidency (TCO), Industrial Development and Renovation Organization of Iran (IDRO)( Representative of Ministry of Industries and Mines), Iran Department of Environment, Iranian Fuel Conversation Organization(representative of Iran Ministry of Petroleum, Iran New Energies Organization, Iran Power Generation, Transmission, Distribution, Management Co.(Tavanir), Research Institute of Petroleum Industry (RIPI), Information Technology Development Center, Iranian Research Organization of Science and Technology (representative of Iran Ministry of Science, Research and Technology ) and active private companies such as Iran Khodro, SAIPA and Dana Environment Research Center.

Rapid increase in the use of non renewable fossil fuels, its limitation and environmental problems due to their application results in serious global attention to exploit and diversify other new energy sources with use of sustainable, secure and environmental friendly methods. Meanwhile, regarding to special features of hydrogen; it is predicted that a significant part of energy needs of future generations will be provided by hydrogen. As experts represent next era will belong to hydrogen and its related technologies (2). Fuel cell technology in which a chemical reaction between oxygen and hydrogen produces electricity and heat is one of the best alternatives to produce the electricity in future. Some of the advantages of this technology are as follow:

- a- High efficiency in comparison with competitive technologies.
- b- Wide range of generating electricity from nano watt to mega watt.
- c- Wide rang of application in various industries such as electricity, transportation, information and communication, military, aerospace and residential.
- d- Possibility of using various fossil and renewable sources of energy as input fuels.
- e- Minimizing environment polluting agents.
- f- Possibility of producing electrical and thermal energy simultaneously.

The importance of hydrogen and fuel cell technology is to some extent that most of countries have been induced to do research and development and have a long term plans. It can be mentioned widespread attempts in Japan, U.S.A and European Union as three focal points in development of this

technology and individual and collaborative activities of some developing countries such as China, South Korea, India and Brazil (4). Currently, 17 countries<sup>2</sup> besides European Commission which have 85% global Gross Domestic Production (GDP) with a population of 3,500,000 persons and electricity consumption of 75% in the world, have founded an union to intensify international cooperation on developing technologies related hydrogen. Therefore, it is expected that fuel cell technology will have a tremendous effect on global market of energy and energy consumption pattern.

On the other hand, achievement to a proper position in this technology in the country is completely possible for the following reasons:

- a- Existence of huge sources of natural gas as one of the most important sources of hydrogen production, and can be used directly in fuel cell.
- b- High potential of human resources in the country.
- c- Existence of experience, scientific strength in transformation and production of fossil fuels.
- d- Existence of infrastructures for natural gas production and distribution in Iran that provide applying fuel cell technology in an expanded level.
- e- Existence of renewable energy sources such as wind, solar and geothermal energy with the potential of producing hydrogen.
- f- The technology is new and there is a little technological gap between Iran and developed countries in the world.

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<sup>2</sup> Japan, China, USA, Russia, France, Canada, Germany, Italy, UK, Brazil, India, Australia, South Korea, Norway, Iceland, New Zealand and European Commission

g- Availability of potential markets for fuel cell technology in transportation and power industry in coming decades and foundation and development of new natural gas markets

Meanwhile, due to the complexity and interdisciplinary technology of fuel cell with different applications in industry and various effects on energy economy, environment, transportation, and major industries in Iran, it is essential to design a national and supra division plan for developing this technology. As a result, national strategy of Iran fuel cell technology development plan is authorized in the following manner to focus on supra division policy making, orientation and coordination of technology development activities and optimum resource allocations.

## ***2- Vision***

With Allah's help, in order to fulfill Iran's 20-year vision together with systematic efforts by the beneficiaries of this technology in a 15-year period, the Islamic Republic of Iran will be one of the five developed, powerful and technological countries in Asia and the first country in the region in designing, producing, advancing and applying strategic fuel cell technology<sup>3</sup> according to the international technology development indicators<sup>4</sup>(6).

Such achievements will bring the following advantages to Iran:

- a- Sustainable development in Energy section via decreasing social and environmental risks caused by growing fossil fuels consumption in Iran

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<sup>3</sup> Titles of strategic fuel cells are given in the strategies section of this document.

<sup>4</sup> These indices have different types and their instances are subject based. Some of them are: the number of national and international inventions and registered patents, Research and development (R&D) budget, quantity and percentage of their usage and export of technological products etc.

- b- Enhancement of sustain, reliability, peak clipping and diversifying country electrical grid via applying fuel cell technology in producing of decentralized electrical power
- c- Decrease in the environmental pollution especially in big cities by applying fuel cell technology in transportation, electricity supply, cooling and heating systems.
- d- Preserving national fossil fuel resources and exploiting them with higher efficiency
- e- Assistance to create and develop of new national and international markets for natural gas resources.
- f- Moving toward knowledge-based economy with participating in supply chain and global market of strategic fuel cell technology and its key technologies with concentration competitive advantages and core competences of Iranian economic institutes.
- g- Conformance global environment commitments and prepared to enter into the Hydrogen era and make possibility to exploit renewable energy sources continuously and efficiently by using fuel cell generators.

### ***3- Major goals***

- a- Design, production and promotion of strategic fuel cell technology in competitive national and international markets with considering priorities of demand market.
- b- The extending and developing of investment in strategic fuel cell production industry and its key technologies and focusing on private section role, competitive advantages, entrepreneurship and export approach (mobilization of supply side).

- c- The creating and developing of application and exploiting capacities of strategic fuel cell technology in Iran and overseas by creating and by using mechanisms such as calculating real costs of energy production, developing niche markets in Iran and enacting required laws and regulation(mobilization of demand side)

#### ***4- Major policies***

- a- The maximum using of capabilities and indigenous competences especially in private sector focused on supportive role of the government.
- b- Centralization in policy making with national and supra division approach and coordination and systematic administration focusing on international cooperation, interaction and partnership in developing strategic fuel cell technology systematically.
- c- Coordination with major strategies and measures of energy sector and renewable energies in the country
- d- Development of exploiting fuel cells in the country and applying in economic and production sections

#### ***5- Strategies (7)***

- a- Development of strategic fuel cells technologies of "Proton Exchange Membrane Fuel Cell (PEMFC)" and "Solid Oxide Fuel Cell (SOFC)", and their key technologies<sup>5</sup> through basic, applied, and developing researches.
- b- Development of technologies related to natural gas reformers into hydrogen, and hydrogen storage.

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<sup>5</sup> The list of these technologies that belongs to strategic fuel cells, has been provided by assessment of technology attractiveness criteria such as goal accomplishment, effectiveness on technical function, ability to create competitive advantages and vast usage that are presented in "Basic Studies".

- c- Helping to create and develop domestic markets, and to penetrate into international markets of fuel cells with application in transportation and electricity production with beginning from early markets of residential electrical generators powered by Proton Exchange Membrane Fuel Cell (PEMFC).
- d- Development and completion of fuel cell National Innovation system(NIS)<sup>6</sup> in Iran, has these headings:
  - 1-Human resource development needed in strategic fuel cell technology development.
  - 2-Conduction and financial and intellectual support for research and innovation in strategic fuel cell technology.
  - 3-Informing, promoting and public awareness on the benefits and advantages of fuel cell technology.
  - 4-Standards formulation, determination of criteria and qualitative and quantitative criterions and legal basis needed to facilitate innovation process in strategic fuel cell technology and its related key technologies.
  - 5-International interaction, foundation and partnership in technology consortia, fuel cell technology development in order to decrease cost and risks of research.
  - 6- Conduction and financial and intellectual support for formation and development of competitive industries in fuel cell technology field focusing on the role of private sector.

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<sup>6</sup> A system comprises of public and private institutes that their activities and interactions result in formation, modification and diffusion of new technologies in a country. Technology development in this approach is driven from activities of all technology beneficiaries in public and private sections and each section plays a different role and performance in technology development. Policy making and conducting of innovation, facilitating and financing the Research and development, technology transfer, human resource development, technology diffusion, promotion of technological entrepreneurship and production and services are main functions of this system. Read more explanations in "Basic Studies".

7-Arranging and facilitating financial resources needed for development of strategic fuel cell technology and its related key technologies.

8-Setting rules and regulations needed for development of strategic fuel cell technology and capacity building for its application in Iran.

9-Development of application of fuel cell technology in transportation system and its related key industries.

10-Encouragement and strengthening of export and overseas marketing.

### ***6-Actions (8)***

Actions are a collection of operational designs and programs that lead to strategies accomplishment and goal achievement. These actions encompass 3 headings according to their periods and durations: short term (2006-2010), mid term (2011-2015) and long term (2016-2020) plans. According to technology cycle of fuel cell and due to lack of appropriate conditions for effective participation of the private sector, the government is responsible for major short term and mid term actions, then in long term plan, developmental researches and application of technology in industry will be transferred to private sector through encouragement, applying supply and demand stimulation policies, developmental researches and applying technology in industry.

### ***Short term actions (9)***

Goal: policy making, research and development activities, rising awareness and technology promotion

a- Establishing fuel cell development council

- b- Formulating and suggesting rules and regulations related to support fuel cell technology development in Iran.
- c- Facilitating scientific, corporation and non government organizations foundation supporting fuel cell technology development.
- d- Foundation and operation of fuel cell technology development with related legal permissions.
- e- Foundation of supportive fund for fuel cell technology development independent or from supportive fund for energy efficiency and renewable energies with relevant legal permissions.
- f- Mastering the design and integration of 5 KW Proton Exchange Membrane Fuel Cell (PEMFC) systems and manufacturing its prototype.
- g- Command over design and manufacturing of single cell and production of Solid Oxide Fuel Cell (SOFC) model.
- h- Command over design and manufacturing of natural gas to hydrogen reformer and manufacturing its prototype.
- i- Command over design and manufacturing of hydrogen storage tank and producing its prototype.
- J- Purchasing, installation and exploiting of some models of different fuel cell systems.
- K- Development of web sites and publication of news bulletins on fuel cell technology achievements in Iran and in the world.
- l- Continuity of strategic studies needed for fuel cell technology.
- m- Preparing action plans needed for operational actions.
- n- Employment and training of expert human resources to implement actions.
- o- Conducting joint educational courses with reputable international centers.

p- Support of master and PhD theses on strategic fuel cells and fuel processing.

q- Support of innovators and inventors achievements in fuel cell technology field.

r- Interaction with international technology consortia.

s- Produce of designing and manufacturing software in strategic fuel cell and their key technologies.

t- Support of research projects in order to benefit from fuel cell in power plants as well as in transportation industries and industrial applications.

### ***Mid term actions (10)***

Goal: continuing research and development activities raise awareness and promotion and establishment of essential infrastructures for technology development.

- a- Study and select an optimum system for fuel processing applies in automobiles
- b- Design and manufacturing of 10 and 25 KW Proton Exchange Membrane Fuel Cell (PEMFC) systems and manufacturing prototype applied in residential generators and transportation systems
- c- Design and manufacture Solid Oxide Fuel Cell (SOFC) models
- d- Formulating of manufacturing, distribution and formulation standards for hydrogen and fuel cell in cooperation with the Institute of Standards and Industrial Researches of Iran (ISIRI) cooperation
- e- Establishing of fuel cell technology growth centers
- f- Developing supportive mechanisms for intellectual Property (IP) for innovations and inventions in fuel cell technology field in cooperation with Iran's Registration office for Documents and Estates.

### ***Long term actions (11)***

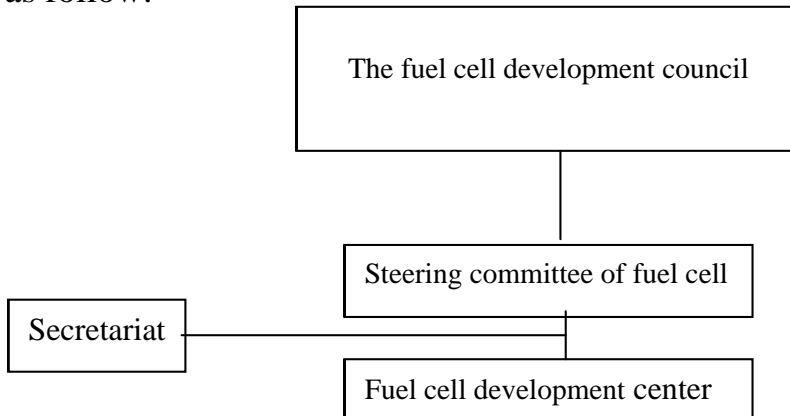
Goal: continuing research and development activities, raising awareness and promotion and initiate deployment of fuel cell technology.

- a- Production and application of Proton Exchange Membrane Fuel Cell (PEMFC) system in residential electrical generators proportionate with target market size.
- b- Production and application of Proton Exchange Membrane Fuel Cell (PEMFC) system in general and especial transportation systems.
- c- Design and manufacturing of 5 and 10 KW Solid Oxide Fuel Cells (SOFC)
- d- Implementation of optimization projects and decrease in final price of strategic fuel cells in order to achieve determined vision.
- e- Encourage various incentive mechanisms for economic institutes producing fuel cell and its related technologies.
- f- Tax free grant for strategic fuel cell and its related technologies, with legal permissions based on specific set of guidelines and regulations.
- g- Awarding financial bank facilities with proper investment condition needed for implementing developmental projects based on strategic fuel cell technology with relevant set of guidelines and regulations.
- h- Formulating guidelines for purchasing electrical power from private sectors which produce electricity via strategic fuel cell technology.
- i- Providing 90 Mega Watt decentralized electrical power from Iran power using fuel cell power plant till 2020.
- j- Formulating rules and regulations for using fuel cell in transportation systems.

k- - Manufacturing and exploiting one hundred public transportation vehicles in mega cities using Proton Exchange Membrane Fuel Cell (PEMFC) driving systems till 2020.

**7- Organizational chart**

In order to accomplish these document objectives, organizational chart will be as follow:



a- Founding fuel cell development council will be set up by the governing body headed by first deputy of the President, and comprised of Iran Ministry of Energy ( Secretary of the council), Ministry of Industries and Mines, Ministry of Petroleum, Iran Ministry of Science, Research and Technology, Ministry of Defense, Ministry of Jihad-e- Agriculture, Ministry of Housing and Urban Development, Chairmen of Iran Management and Planning Organization , Iran Environment Protection Organization , Technology Cooperation Office of Presidency(TCO) and Iran New Energies Organization.

b- The steering committee of fuel cell is set up under supervision of fuel cell development council comprises of : undersecretaries of its members, together with representatives from ministry of jihad-e- agriculture

engineering research center, 2 elites from university and industry fields selected by fuel cell development council to conduct and monitor fuel cell technology development measures and to create and activate the secretariat of Fuel Cell Technology Development council which is located at the ministry of energy.

c- Establishing fuel cell development center under supervision of steering Committee, to lead technology and research areas of fuel cell technology development and if recognized essential by steering committee, carry out especial areas of research and measures needed.

Steering committee is in charge of supervising and monitoring accurate performance of all items of this document.

f- Budget allocated to fuel cell development from public budget is delivered to executive organization which is also in charge of the secretariat of the council and will be spent after obtaining legal permission from fuel cell technology development national strategy framework, regarding relevant regulations and manuals adjusted with approved programs by the special office or steering committee.

g- Action plans and agendas of council and steering committee will be organized by secretariat and related system and after approval by steering committee, will be presented to fuel cell development council.

h- Steering committee is responsible for projects, division and supra division programs and supervising actions and operation.

i- According to rapid trend of fuel cell technology growth and new global commitments, this document should be revised and controlled every 2 years. (If recognized by steering committee, and approved by fuel cell technology development council)

### ***References***

1-"Basic Studies", started in 1/06/1381 and ended in 1/06/1383.  
Documents of this study are presented in 3 stages, 21 phases and 2900 pages in fuel cell technology development special office secretariat.

2-"Basic Studies", first stage, phase 2

3-"Basic Studies", first stage, phase 1 and 2<sup>nd</sup> stage, report 1, appendix 1

4-"Basic Studies", first stage, phase 3 and stage 3, chapter 1

5-"Basic Studies", first stage, phase 7

6-"Basic Studies", first stage, phases 4 and 7

7-"Basic Studies", second stage, reports 2 and 3 and first stage, phases 5 and 6

8-"Basic Studies", 3<sup>rd</sup> stage, chapter 2

9-"Basic Studies", 3<sup>rd</sup> stage, chapter 2

10-"Basic Studies", 3<sup>rd</sup> stage, chapter 2

11-"Basic Studies", 3<sup>rd</sup> stage, chapter 2

12-"Basic Studies", first stage, phase 7

13-"Basic Studies", 3<sup>rd</sup> stage, chapter 2

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