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DEVELOPING PARTNERSHIP FOR DISSEMINATING ENVIRONMENTALLY SOUND TECHNOLOGIES

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DEVELOPING PARTNERSHIP FOR DISSIMENATING ENVIRONMENTALLY SOUND TECHNOLOGIES

Lulwa N. Ali
Sustainable Development and Productivity Division,
Economic and Social Commission for Western Asia (ESCWA)
P.O. Box 11-8575, Beirut, Lebanon
ali59@un.org

ABSTRACT

The development and use of cleaner fossil fuels represents one of the important measures for reducing Greenhouse Gases (GHG) emissions and achieving the energy sector sustainability. Arab countries have achieved during the last two decades reasonable success in promoting the use of cleaner fuels particularly Natural Gas in the power sector. Meanwhile fuel cells and compressed natural gas (CNG) are emerging as potential sources of alternate fuels for transport, with rapid advances in the technology, resulting in more efficient energy use, the economics becoming more viable and feasible. This is certainly the case for CNG powered vehicles, which is emerging as an attractive market potential.

To enable the dissemination of such sustainable technology, a number of stakeholders need to coordinate their efforts and build a well-organized partnership for achieving this objective. Key partners to this effort include private/ public research centers, fuel suppliers, vehicle manufactures, funding agencies, regulators, market developers, environmental NGOs and activists, end-users, etc. These stakeholders are collectively responsible for developing a strategic framework for smooth dissemination of environmentally sound technologies. They are also expected to work in partnership, each within own capacity and mandate, toward achieving several main goals including: Awareness, Access to technology, Capacity building, and Financing and Market development.

This paper reviews available environmentally sound technology for transport with emphasis on compressed natural gas (CNG) vehicles. Related experiences and potentials in the Western Asia Region are also presented. The paper also discusses the requirements needed to achieve the above-mentioned goals and identifies the potential stakeholders involved in each. Furthermore, a general strategy framework for implementing the use of CNG vehicles technology in the ESCWA region member states is proposed.

A. INTODUCTION

The total world commercial primary energy consumption increased by almost 10 per cent during the period 1992-1999. About 75 percent of this increase was met by oil and natural gas. The growth in demand for oil and natural gas was due to environmental considerations, price competitiveness and growth in supply capacity as well as the lack of competitive, non-petroleum alternatives for transportation fuels. The transport sector accounts for about 25 per cent of the total commercial energy consumed worldwide and consumes approximately one half of the total oil produced. Between now and 2020, energy demand for transport is forecast to grow by 1.5 per cent per year in industrialized countries and by 3.6 per cent per year in developing countries [(1)].

The transport sector is plays a vital role in the sustainable development process as it has profound economic, social and environmental implications. The emissions associated with transport include Greenhouse gas (GHG), particulate matter, lead, nitrogen and sulfur oxides and represent a serious threat to environment and human health. Adverse noise and land-use impacts, accidents and congestion associated with unsustainable transport systems also imply costs to society and seriously affect sustainable development.

The provision of adequate transport services and securing necessary financing remains a serious development barrier for many developing countries. The transfer of cleaner technology and the upgrading of vehicle fleets represent other barriers that needs to be overcome. The United Nations and the World Bank have jointly initiated the Global Initiative on Transport Emissions (GITE) to promote private-public partnerships as a means of improving the knowledge base and fostering the transfer of cleaner vehicle and fuel technologies [2].

In the ESCWA region the transportation system relies nearly completely on petroleum-based fuels. In 2000, the road transport accounted for almost 44 percent of final petroleum products consumption in the region and mainly gasoline and diesel fuel. Thus the transport sector in ESCWA accounts for a substantial share of pollutant emissions, particularly greenhouse gases and particulate matter [3].

The emitted pollutants coupled with the high growth rates of travel impose a serious threat to local and global environments, human health and sustainable development. Extensive efforts have been going on for many years to establish mitigation measures and to seek alternative fuels and technologies to control and reduce the negative environmental impacts associated with transport. Luckily, these efforts have resulted in identifying promising fuel alternatives and technology, which if implemented and used could lead to a cleaner environment without jeopardising the ultimate goal of sustainable development.

B. ADVANCED TECHNOLOGY VEHICLES

Advanced technology vehicles provide alternative sources of energy to traditional gasoline and diesel fuels. Promising alternative fuels now used to power vehicles mainly include (1) electric vehicles using batteries, fuel cells or hybrid source; and (2) clean fuel vehicles using compressed natural gas, methanol, ethanol, propane, and hydrogen. This paper will focus on Compressed Natural Gas (CNG), the most promising technologies in transport sector, which are further discussed below. For further information on other technologies, the reader is referred to ESCWA report on GHG emissions in the ESCWA region[4].

NATURAL GAS VEHICLES (NGV)

The only major difference between a gasoline vehicle and a Natural Gas Vehicle (NGV) is the fuel system. Natural gas can be stored onboard a vehicle in pressurized tanks. Currently, in the use of natural gas, emphasis is on CNG, but LNG is being increasingly looked into because of its storage benefits, although the technology for transferring LNG from a refuelling station to a vehicle and vaporizing it en route to an engine largely remains to be demonstrated. There are three Types of natural gas vehicles: Bi-fuel (runs on either natural gas or gasoline); Dual-fuel (runs either on

diesel fuel only, or diesel fuel and natural gas simultaneously) and Dedicated vehicles (runs on natural gas only).

The use of gas-fuelled vehicles has grown rapidly. There are over a million natural gas vehicles in the world and 3,951 fuelling stations in over 46 countries. Most of these vehicles can run on either gas or gasoline (Bi-fuel). The widespread introduction of vehicles that run solely on natural gas (Dedicated) would make an even greater contribution to reducing emissions of major pollutants such as CO_2, CO, NO_x, non-methane hydrocarbons and SO_x. These vehicles have a long-established record in Europe, Canada, New Zealand and Australia. There are approximately 579,000 vehicles in Argentina (46.1), while Italy has more than 320,000 NGVs (25.5 percent). Over 90,000 natural gas vehicles (NGVs) (7.2 percent) are on U.S. roads today. In Canada, nearly 40,000 NGVs operate with a network of 125 public fuelling stations, and Russia has more than 200,000, with plans to convert one million vehicles by the end of this decade. Egypt has about 30,000 NGV (2.2 percent) of the worldwide fleet and 1.6 percent of the fuelling stations in the world[5].

Currently, natural gas powered vehicles are offering a combination of environmental and economic benefits for taxicabs in Southern California. The natural gas vehicles used there are 14 times cleaner than the average car in Southern California; Each year, American Livery's 76 NGV taxicabs will reduce air pollution by over 53 tons (based on a yearly driving cycle of 70,000 miles); American Livery's total fleet of 104 NGVs will reduce pollution by over 73 tons each year with a reduction in annual maintenance costs of $1,300 per vehicle; A $0.48 cost saving in Southern California between a gallon of gasoline and equivalent gallon of natural gas converted to a $2,260 annual saving for taxicabs driving 80,000 miles per year[6].

The published data on GHG emissions from the use compressed natural gas (CNG), liquefied petroleum gas (LPG), alcohol fuels (ethanol, methanol) and traditional (gasoline) fuel, revealed that CNG produce the lowest carbon dioxide emissions across the total fuel cycle followed by LPG [*].

BENEFITS OF NATURAL GAS TRANSPORTATION

Environmental benefits:

Exhaust emissions from NGVs are much lower than those from gasoline-powered vehicles. For instance, NGV emissions of carbon monoxide are approximately 70 percent lower, non-methane organic gas emissions are 89 percent lower, and oxides of nitrogen emissions are 87 percent lower. In addition to these reductions in pollutants, NGVs also emit significantly lower amounts of GHG and toxins than do gasoline vehicles.

Economic benefits:

Natural gas costs an average of 15 to 40 percent less than gasoline and diesel [7]. Natural gas is a clean-burning fuel that reduces vehicle maintenance. Many NGV owners report that oil changes are needed only every 10,000-20,000 miles. Standard spark plugs last as long as 75,000 miles. In the USA, the typical cost to convert a light duty gasoline vehicle to NGV ranges from $3,000 to $5,000. Converting larger vehicles costs more. Dedicated NGVs cost $3,500 to $7,000 more than

[*] According to Energy Information Administration (EIA), non-stage vehicle of the fuel cycle is referred to all other types of fuel processes from resource recovery through energy transformation prior to end-use consumption (i.e. vehicles).

gasoline vehicles, however, economies of scale will lower this cost. NGVs will cost approximately $800 more than comparable gasoline models when mass-produced. It is important to mention here that, the conversion cost varies from one country to another depending on the technology used and labour cost. Currently, in Egypt, the conversion cost of passenger car from gasoline to NG is about $ 1,500 only. The payback period for conversion to NG depends on conversion cost, fuel cost, distance travelled and vehicle fuel efficiency. Estimated payback period based on Egyptian experience may range from 19 months at 15 liter/day to 4 months at 70 liter/day [4].

Social benefits:

It is estimated in USA that the direct investment in CNG vehicle fabrication, fuel station and infrastructure construction, and in vehicle and station maintenance will create by end of year 2000 13,500 direct jobs, in addition to 30,000 jobs due to indirect investment. In Egypt, the development and expansion of CNG vehicle industry has created over 600 new jobs to date since 1996 and is providing many related business opportunities to support this growth [5].

Natural gas vehicles are also safer than gasoline vehicles as compressed natural gas, unlike gasoline, dissipates into the atmosphere in case of an accident [4]. A survey on more than 8,000 vehicles that cumulatively travelled approximately 278 million miles from 1987-1990 in the USA, the injury rate for NGVs per vehicular mile travelled (VMT) was found to be 37 percent lower than conventional vehicles. In addition, no deaths were reported for NGVs in the survey, in contrast 1.28 deaths per 100 million VMT for gasoline fleet vehicles surveyed [4].

C. EXPERIENCES AND POTENTIALS IN THE ESCWA REGION

Egypt has several years of experience and about 30,000 CNG vehicles [5]. The evaluation of the Egyptian experience in terms of investment, cost and performance indicated the following [4]:

- The average cost of vehicle conversion to natural gas is around 5,000 LE (1,300 US$);
- The cost of natural gas is 0.45 LE/m^3 (0.108 US$/$m^3$) compared with 1.0 LE/lit (0.24 US$/lit for gasoline;
- From the actual statistical fuel and maintenance costs for diesel bus - compared with similar buses converted to run on CNG - proved that the converted bus cost represents 65 percent of the diesel one;
- NGV owners report that oil changes are needed only every 10,000-20,000 miles. Standard spark plugs last as long as 75,000 miles.

Based on an average estimated annual fuel consumption of 10 liter/day to be (1.8 ton/year) for gasoline vehicle and 35 liter/day (7.65 ton/year) for diesel vehicle, the potential GHG reductions due to CNG conversion in Egypt are evaluated. The evaluation investigates the effect of conversion to CNG on GHG emission reduction in Egypt assuming that 25 percent of gasoline vehicles and 15 percent of diesel vehicles convert to CNG. The conversion plan could be implemented in 5 stages for gasoline vehicles (5% for each stage, 80,000 vehicles), and 3 stages for diesel vehicles (5% for each stage, 35,000 vehicles). The results (Table 1) indicated a potential annual reduction in CO_2, NO_x, CO, and NMVOC as 950,948 ton (20%), 33,594 ton (69%), 292,449 ton (97%), and 44,507 ton (78%) respectively. It is worth mentioning here that, CH_4 emission for CNG is expected to be higher than gasoline or diesel as it is the main component of natural gas [4].

The Use of CNG technology in the ESCWA region is expected to provide economic and environmental benefits. The region has huge reserves of natural gas, and it is economically more profitable to maximize local use of natural gas rather than its exportation. CNG experience in Egypt provides a successful model and can be replicated in other countries in the ESCWA region. The replicability potentials assuming the conversion of 25 percent of gasoline fleet and 15 percent of diesel fleet, representing 22 percent of total vehicles in the region, into CNG was evaluated. The results indicated that the total ESCWA countries annual reduction in CO_2, NO_x, CO, and NMVOC will be (20%), (72%), (97%), (79%), respectively as shown in Table 2.

TABLE 1. GHG REDUCTION AS A RESULT OF SWITCHING TO CNG IN EGYPT (TON/YEAR) [4]

Vehicles converted to CNG	%	Average fuel cons. (ton/year)[1]	[4] CO_2		[4] NO_X		[4] CO		[4] NMVOC	
			Before CNG	CNG Reduction.	Before CNG	CNG Reduction	Before CNG	CNG Reduction	Before CNG	CNG Reduction
Gasoline										
400,000	25%	720,000	2,235,312	376,978	19,951	7,781	266,012	258,031	49,877	37,408
Diesel										
105,000	15%	803,250	2,577,629	573,970	18,681	25,813	35,852	34,418	7,170	7,099
Total[2]										
505,000	22%	1,532,250	4,812,941	950,948	48,632	33,594	301,864	292,449	57,048	44,507
			Reduction = 19.76%		Reduction = 69.08%		Reduction = 96.88%		Reduction = 78.02%	

[1] Based on: fuel consumption of 10 liter/day and 300 working days per year for gasoline vehicle and 35 liter/day and 300 working days per year for diesel vehicle. [2] The summation of 400,000 gasoline vehicles and 105,000 vehicles. [3] Calculated based on CO_2 emission factors of 3.1046 Ton/ton in gasoline and 3.2093 Ton/ton in diesel fuel. [4] Calculated based on measurements recorded by Petrobel (Pelayim Petroleum Company of Egypt) emission reduction of NOx by 39%, CO by 39% and MNVOC by 75%.

D. GOVERNMENTS POLICY OPTIONS FOR DISSEMINATING CNG VEHICLE TECHNOLOGY

The formulation of adequate policies seeking optimal utilization of energy in sustainable development basically is a government responsibility. The implementation of these policies could however be best facilitated through the involvement of concerned beneficiaries and stakeholders. Selected policy options are usually country specific and depend on national circumstances and needs[8]. Accordingly, governments are expected to play a leading role in the implementation of the CNG fuel program in the transport sector. This implies setting a range of policy options that would best facilitate the CNG vehicle take-up and market penetration[9]. These policy options should be formulated to:

TABLE 2. GHG EMISSION REDUCTION AS A RESULT OF SWITCHING TO CNG IN THE ESCWA REGION[4]

Country	Fuel type Vehicle	Number of Vehicles converted to CNG (25% gasoline, 15% diesel) (*)	Average fuel consumption (ton/year)	Reduction			
				CO_2	NO_X	CO	NMVOC
Bahrain	*Gasoline*	35,964	64,249	33,639	694	23,025	3,338
	Diesel	4,916	37,606	26,872	1,209	1,611	332
Egypt	*Gasoline*	400,000	720,000	376,978	7,781	258,031	37,408
	Diesel	105,000	803,250	573,970	25,813	34,418	7,099
Iraq	*Gasoline*	171,132	308,037	161,282	3,329	110,393	16,044
	Diesel	52,828	404,133	288,777	12,987	17,316	3,571
Jordan	*Gasoline*	47,499	85,497	44,765	924	30,640	4,442
	Diesel	14,074	107,666	76,934	3,460	4,613	951
Kuwait	*Gasoline*	186,760	336,168	176,011	3,633	120,475	17,466
	Diesel	21,072	161,201	115,188	5,180	6,907	1,425
Lebanon	*Gasoline*	324,850	584,729	306,152	6,319	209,553	30,380
	Diesel	13,811	105,656	75,498	3,395	4,527	934
Oman	*Gasoline*	61,283	110,310	57,756	1,192	39,533	5,731
	Diesel	16,058	122,841	87,777	3,948	5,264	1,086
Qatar	*Gasoline*	41,180	74,124	38,810	810	26,564	3,851
	Diesel	11,867	90,780	64,868	2,917	3,890	802
Saudi Arabia	*Gasoline*	873,020	1,571,436	822,773	16,982	563,167	81,645
	Diesel	449,816	3,441,095	2,458,869	110,583	147,444	30,410
Syria	*Gasoline*	34,615	62,307	32,623	673	22,329	3,237
	Diesel	45,445	347,656	248,421	11,172	14,896	3,072
UAE	*Gasoline*	82,938	149,288	78,164	1,613	53,502	7,756
	Diesel	13,228	101,195	72,310	3,252	4,336	894
Yemen	*Gasoline*	80,507	144,912	75,873	1,556	51,933	7,529
	Diesel	62,724	479,841	342,875	15,420	20,560	4,241
Total ESCWA	*Gasoline*	2,339,477	4,211,058	2,204,826	45,508	1,509,147	218,787
	Diesel	810,839	6,202,920	4,432,358	199,337	265,783	54,818
Grand total ESCWA		3,1503,316	10,413,978	6,637,184	244,845	1,774,930	273,605
Reduction (%)		**22%**		**20.1%**	**72.4%**	**96.8%**	**78.8%**

(*) For illustration, it is assumed that the same percentage of vehicles would be converted in each country. In reality, the percentage would differ according to the circumstances in each country.

1. Facilitate the shift to CNG vehicles and fuels.
2. Set technical standards for vehicles, fuels and distribution infrastructure
3. Facilitate the development of CNG fuel distribution infrastructure
4. Set appropriate taxation incentives for investors and end users and /or subsidy to CNG vehicle ownership, fuels and infrastructures investments.
5. Encourage consumer take-up of new vehicles and fuels including action to overcome financial and other market barriers;
6. Make fullest use of CNG vehicles and fuels in public vehicle fleets to encourage other sectors and end users to do so.

7. Promote research, development and demonstration of new vehicles and new fuels

8. Ensure public and local communities confidence in the safety and environmental integrity of new fuelling infrastructure, by waging necessary awareness programs.

E. REQUIREMENTS FOR DISSEMINATING CNG TECHNOLOGIES

To enable the dissemination of CNG technology in the transport sector, a number of stakeholders need to coordinate their efforts and build a well-organized partnership for achieving this objective. Key partners to this effort include private/ public research centers, NGOs, fuel suppliers, vehicle manufactures, funding agencies, regulators, market developers, NGOs and environmental activists, end-users, etc. These stakeholders are collectively responsible for developing a strategic framework for smooth dissemination of environmentally sound technologies. They are also expected to work in partnership, each within own capacity and mandate, to achieve several main goals including: Awareness, Access to technology, Capacity building, Financing and Market development.

1. Awareness

There are over a million NGVs in the world today, yet many people are not properly aware and informed about this technology. Lack of awareness and insufficient information adversely affects the spread of NGVs and shrink their markets. It is therefore necessary that the environmental, technical and economic features of the NGVs be clearly and repeatedly explained to the public through appropriate awareness campaigns. Awareness campaigns may involve government, industry, national and international organizations involved in technology development, environmental and grassroots organizations, NGOs concerned with sustainable development, investors, etc.

Tools to promote NGV are similar to those used in promoting any new technology. These tools include: publications, television, Radio, and information technology tools, Exhibits, etc. Components of these tools could include the following:

- *Publications:* e.g. Newspapers and magazines, dedicated magazines (automotive, scientific, environmental, CNGV product manufacturer's catalogues, dedicated books reports and brochures

- *Television:* Promotional video records, Interviews and reports, Coverage of CNG related events and awareness programs

- *Radio: e.g.* Promotional programs, Interviews and reports, Coverage of CNG related events and awareness programs

- *Trade shows and exhibitions in related events:* e.g. Automobile and/ or dedicated trade shows; Technology exhibitions

- *Modern IT tools:* e.g. Internet information sites, dedicated web sites

2. Access to technology

Access and transfer to CNG technologies is a vital need for many developing countries. Necessary support is thus needed to enable transfer of technology know-how, build necessary technical and management capacities, as well as building financial support and economic capacities. Ensuring access to technology requires the joint efforts of governments, investors, industries, research and technology centres and end users.

Ensuring adequate accessibility to CNG energy fuel technologies implies developing necessary measures and seeking appropriate means by which CNG vehicle technology and fuel supply can be delivered reliably, affordably, in an economically viable, socially acceptable and environmentally sound manner[10]. To achieve this governments are encouraged to:

- Establish national and regional arrangements to ensure CNG reliable energy supplies;
- Support research and development to provide technical support for CNG implementation plans;
- Develop CNG production/ distribution infrastructure
- Develop necessary technical capacity building, and maintain rational pricing
- Fund and seek funds from international and regional agencies and donor countries for sustainable CNG energy

3. Capacity building

The main stakeholders to be involved in capacity building for CNG vehicle technology dissemination include government, industries, investors, research and development centers and end users.

Due to the gap in their technological and economic standing, capacity-building (technical, managerial, economic) represents is a major barrier facing the implementing of CNG fuel technology in developing countries. Building the basic required capacities in CNG technologies are thus needed to enhance the capabilities of concerned transport sector authorities and institutions, to facilitate the development of necessary infrastructures and to train involved human resources.

To overcome the technological and financial barriers facing the Capacity building in developing countries regional and internal cooperation may become necessary. Assistance in this respect could be acquired and enhanced through regional and international public and private cooperation with developed countries and organizations supporting sustainable development objectives.

Developing countries should seek assistance from available funding sources including World bank, developed countries, regional and international development banks, United Nations organizations including the regional commissions, etc. to acquire their capacity-building in CNG technical and management issues. The GEF fund is also a viable source of funding which could provide support for capacity building and technology transfer to

developing countries for energy technologies targeting the global of sustainable development.

4. Financing

Availability of financial resources and mechanisms/ measure play a key role in the implementation of the compressed natural gas as an alternative fuel in the transportation sectors. In general, financing would come primarily from a country's own public and private sectors. Due to financial constraints in some developing countries, it is important to seek additional external funding.

To attract international and private sector investments in CNG vehicle technology, concerned governments must establish and endorse necessary reforms to improve the efficiency of regulatory frameworks related to investment. Governments are also encouraged to develop incentives and foster the private sector participation in CNG vehicles investments. Policies must aim specifically at inducing the flow of investment capital for CNG energy should be formulated and implemented. These reforms and specific policies to attract funding and investment are necessary due the fact investment in new technologies is capital intensive compared with other available alternatives. This is the case of the CNG technology, which requires greater initial infrastructure investments in developing countries.

Potential sources of financing, besides national private sector, include regional and international funding and investment agencies. Soft loans from financial institutions concerned with sustainable development should as well be approached.

5. Market development

Market driven economies, which are led by the private sector investments, have proven to be a very effective tool in economic development. Markets are usually more efficient than the public sectors as they are governed by competitiveness and competition. It is therefore necessary that concerned governments take necessary measures to overcome market barriers facing the CNG fuel technology and to enhance the performance of the markets without violating the goals of sustainable development.

Governments should implement policies that would help reduce CNG market barriers and incentives that will attract investors. Many options are available and include: removing existing barriers to alternative renewable sources, endorse energy efficiency measures, secure sustainable CNG energy supply, set adequate pollution control measures and subsidize CNG energy technologies. Among other tools, Governments are also encouraged to reduce and gradually eliminate subsidies for gasoline fuel that inhibit sustainable development.

Many stakeholders are involved in market development include government, industries, investors and end users (consumers). The main effort in developing CNG vehicle market is however the responsibility of the government. Governments are responsible for facilitating the start up of the market.

Since it is ultimately consumers who determine whether or not a new product take off. Government should work to ensure that consumers feel able to take early and full advantage of

CNG vehicles and fuels, as well as associated environment benefits. In particular, the Government should:

- Provide purchase grants for CNG vehicles, with particular emphasis on encouraging manufacturers/ suppliers to move CNG gas fuel models on to assembly line production, bringing down costs and making them a mainstream market option for vehicle purchasers;
- Provide grants for CNGV to help offset the higher costs and small initial market;
- Provide consumers with information on the availability, performance and safety of new vehicles and fuels – and also information on whole-life costs, for example where new vehicles have higher up-front purchase costs, but low running costs;
- Work with the industry and financial service providers to develop new ways in which vehicles can be bought, owned or leased;
- Provide information updates on the environmental and economic performance of new vehicles and fuels.

F. STRATEGY FRAMEWORK FOR IMPLEMENTING CNG FUEL IN TRANSPORT SECTOR

The successful implementation of the CNG fuelled vehicle technology in the transport sector of interested countries in the ESCWA region necessitates the involvement of all concerned parties. To achieve this, it is essential to develop a strategy that identifies and coordinates the associated activities among the different stakeholders. It would also be favourable if such a strategy is phased into several consecutive stages with specific steps to allow smoother implementation and more effective follow-up. Below is a proposed strategy outline that could be implemented taking into consideration the specific national circumstances and needs of the concerned ESCWA countries.

Stage 1: Mobilizing the initiative

- Government tentative endorsement of the initiative (which states commitment to implement the technology).
- Establishment of a national team of experts and stakeholders to set the terms of reference target objectives which best reflect optimal possible combination of stakeholder interests governed by the objective of national sustainable development in the country.
- National endorsement of the initiative and target goals.

Stage 2: Setting the plan

- Define national capacities: availability NG, technology know how, infrastructure (fuel stations, supply and distribution networks), market size and potential, potential investments, availability of funds, available industries, technical support, regulations, etc.
- Define needed requirements: NG resources available, supply alternatives, new or additional infrastructures, technology know how, funds, industries, etc.).

- Identify feasible mechanisms to meet necessary requirements (regional NG resources, technology transfer, tax laws, government subsidy, international funds/ subsidy, regulations, etc.)
- Set tangible targets (percent of pollution reduction on a target date, percent of converted cars to CNG in public or government sector on target date, etc.)
- Define strategies to achieve the targets (promotional tools, policy tools, funding mechanisms, subsidy, tax incentives, infrastructures, investment alternatives, etc.).

Stage 3: Implementing the plan

- Awareness Campaigns (end user acceptance/ support)
- Access to technology (technology transfer, know how, information, availability, industry and/or market competitiveness, etc..)
- Capacity building (NG resource availability, infrastructures, maintenance, technical support, etc.).
- Financing (government subsidies to industries and end users, regional international financing and subsidies, etc.).
- Market development (policies and programs to attract investments, incentives, sales strategies, etc.).

Stage 4: Follow up and achievement evaluation

- Evaluate achievements
- Identify barriers for unachieved objectives

Stage 5: Revise and roll the plan

- Achieved objectives
- Unachieved objectives
- Technology improvements
- Emerging national needs/ opportunities
- Revise the plan

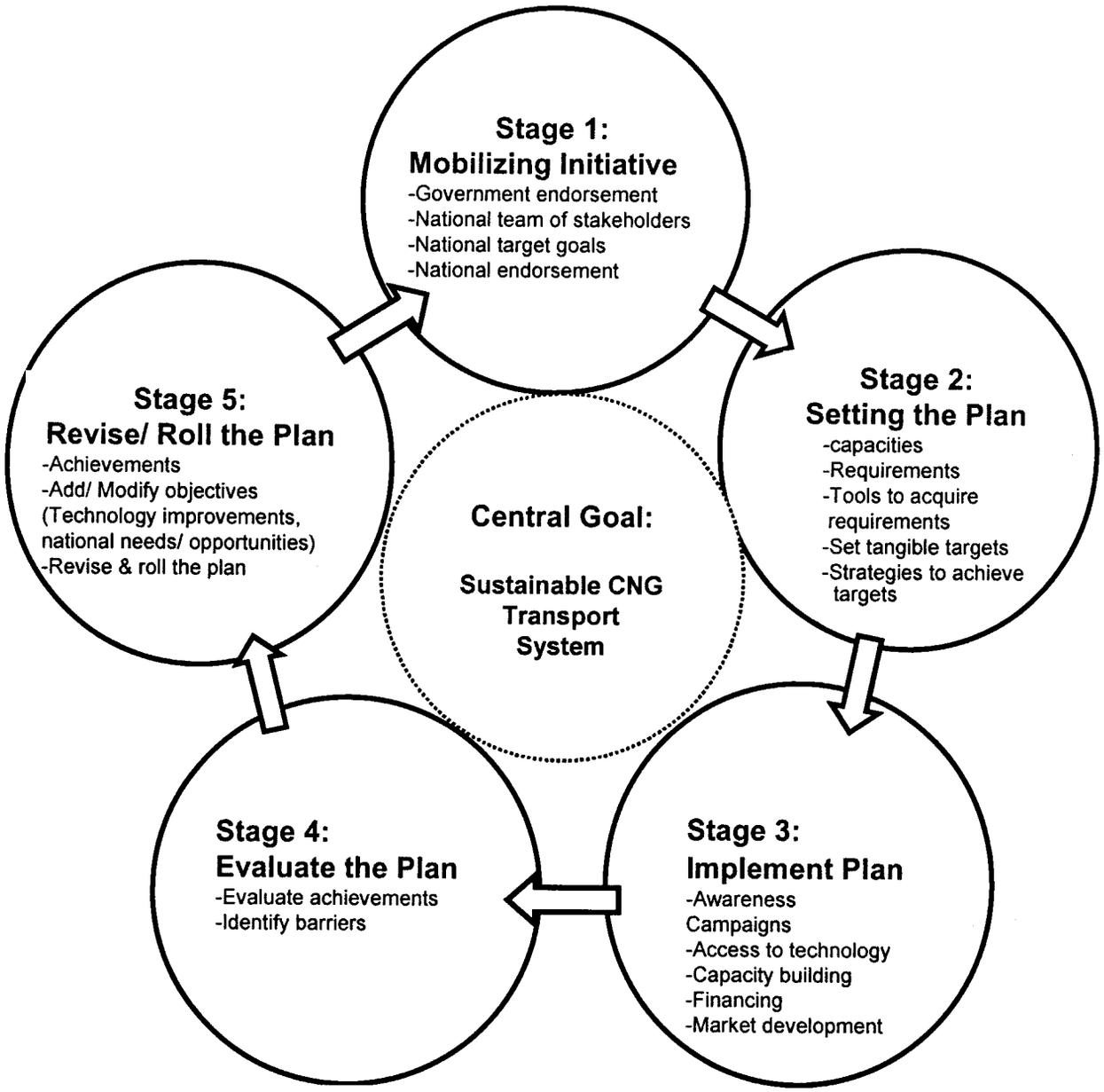

Figure 1: Strategy Framework for Implementing CNG in Transport Sector

G. SUMMARY AND CONCLUSION

It has been well established that CNG vehicle technology is a viable alternative technology option, which has many economic and environmental benefits. This technology has been implemented successfully in many countries. The experience of Egypt demonstrates potential implementation of CNG in transport in other ESCWA countries. However, serious efforts have to be exerted to achieve this goal. Many barriers do exist including technology accessibility, capacity building and financing and need to be overcome. These issues among other related matters were addressed in this paper and a conceptual strategy framework was proposed for CNG utilization in transport sector in ESCWA, and could be tailored to country specific interests and circumstance. Further related detailed studies and serious initiatives are however needed to accomplish this task, which would, if achieved, positively impact sustainable development and sound environment.

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