Energy Options for Iran

Findings from: Decentralised Energy Generation Opportunities in Iran:

WADE[1] Economic Model Application Report

World-wide, governments, investors, corporations, non-governmental and inter-governmental actors are involved in a discussion about energy choices: choices that will define our world, affect our security and shape our environment.

A huge environmental, economic and social cost has been paid for the use of conventional energy sources: smoke from coal and fumes from oil poison the air, choke cities and pump out greenhouse gases that cause global warming; nuclear waste and accidents kill humans and wildlife and pollute the air, land and sea. The need for secure, stable and reliable energy sources and the need for fair access of all to energy services require a rethink of our energy supply, distribution and consumption.

In Iran the energy debate is no less important. This energy report is offered as a contribution to the debate about energy pathways and choices currently happening in Iran. Greenpeace welcomes the opportunity to contribute to this debate.

Greenpeace commissioned a report from the World Alliance for Decentralised Energy (WADE) to show a range of energy options for Iran. The study demonstrates the benefits of policies that encourage the uptake of renewable energy, decentralised energy systems and energy efficiency. These benefits include the protection of the environment and human health and reducing capital costs while still meeting the energy needs of Iranian people and industry.

Key Findings

The three most effective ways to minimise costs and environmental impacts from the power sector in Iran are:

- ***Decentralised Energy*** – generating energy at or near the point at which it is needed, including the efficient co-generation of heat.
- ***Renewable Energy*** – using Iran's wind, solar, biomass and geothermal energy sources to meet an increasing portion of new electricity requirements.
- ***Demand side Management*** – satisfying service needs while reducing the requirement for electricity generation – for instance through energy efficiency.

Using such systems, Iran can meet future energy needs at lower cost, using less natural gas, and with more cost-efficient reductions in greenhouse gas emissions than through traditional centralised production of electricity. Iran can do without nuclear power and reduce its dependence on fossil fuels, while meeting the needs of its people and its economy. These are options which can be developed and discussed within Iran, and Greenpeace is pleased to make the study data and model available for this use.

The Energy Question

How do we meet energy needs of people without compromising the environment, social welfare and economies? The threat of climate change means we need to move towards energy sources which do not add further to greenhouse gas emissions. Security of energy supplies is a major issue; as fossil fuel and nuclear resources are finite and as resources dwindle and prices rise, so competition intensifies, increasing

[1] World Alliance for Decentralised Energy (WADE) has experience developing energy scenarios for a wide range of industrial and developing countries. Help for the study has been kindly provided by discussions with Tehran University's Research Institute for Energy Management and Planning at Tehran University. We appreciate their support and are making the study data available to them for further work.

the threat of military conflict over these resources. Further, nuclear power carries an intrinsic threat of the proliferation of nuclear weapons, wherever in the world it is used or developed.

Renewable Energy in Iran

Though rich in oil and gas, Iran, like many other countries in the Middle East, increasingly recognises the need to diversify energy sources, to ensure security of supplies and provide for more consistent energy costs. Renewable energy technologies, as well as decentralised energy systems and energy efficiency programmes, are realistic options without the environmental impacts of conventional fuels.

Research by the Iran Renewable Energy Organisation, founded by the Ministry of Energy, shows that wind power, biomass and geothermal energy have a huge potential. Solar energy is also abundant in Iran, with a potential of 2,000 kWh/m^2, but it is mostly used for thermal applications, and photovoltaic systems are currently used for agricultural and frontier situations.

TABLE 1: POTENTIAL FOR NEW RENEWABLE ENERGY SOURCES IN IRAN

Technology	Potential	Projected capacity 2030
Wind energy	6,500 Mwe	2,000 Mwe
Biomass	22,000 MWth	N/A
Geothermal energy	1,000 MWe	260 Mwe
IEA, 2005; WÜPPERTAL INSTITUT, 2006.		

The Energy Model

The WADE model provides results on the capital costs, delivered electricity costs, CO_2 and other pollution emissions, fuel use and electricity generation for a baseline scenario and a number of sensitivity scenarios. For each scenario the results compare centralised generation (CG) with various quotients of decentralised generation.

Decentralised energy (DE) technologies encompass energy generation systems that produce heat and electricity at, or close to, the point of consumption. They include: high-efficiency cogeneration of combined heat and power; on-site renewable energy systems; energy recycling systems, including the use of waste gases, waste heat and pressure drops to generate electricity on-site. WADE classifies such systems as DE regardless of project size, fuel or technology or whether the system is on-grid or off-grid.

Using current conditions and planned investments in Iran's energy sector as a starting point, the report examines the advantages of investing in smaller scale localized energy production versus the current model with its large centralised generating facilities. The study also demonstrates what would happen if Iran adopted a target of meeting 20% of its energy needs with renewable energy sources by 2020; the same goal as the European Union.

Two baseline scenarios are considered, then each is developed using a number of variable factors. The first baseline scenario represents the electricity system in Iran as it is projected to develop over the next 20 years – that is a centralised generation (CG) scenario. Under this projection, case most of the new electricity demand is met by natural gas-fired combined cycle gas turbine (CCGT) power stations, which replace existing steam turbine plants and open cycle gas turbines. Other new generation capacity includes large hydropower stations, such as at Karoon, and the Bushehr 1.0 GW nuclear power plant, due to open in 2008.

The second baseline scenario considers the application of decentralised energy (DE). In this pathway, the majority of **new** demand is met by industrial on-site gas engines and combined heat and power (CHP) plants, using both oil and natural gas. Initially most on-site generation is electricity only, but CHP cogeneration forms an increasing share of new generation over the 20-year period, so that after 20 years

20% of the total CHP potential is achieved. Small, but increasing, amounts of biomass cogeneration and other renewable energy generation also meets future electricity demand in this scenario.

These baseline scenarios are then evaluated against two major variables affecting the power generation field. The first of these looks at how the baseline scenarios are affected by both high and low growth in fuel prices. The second variable assessed is the growth in demand for electricity, and again, both a high growth rate and a low growth rate are considered.

Thus, the study looks at a range of future possibilities – from a business-as-usual model, to a modest shift towards renewable energy and decentralised energy. Changes are only proposed for Iran's NEW generating capacity, not for existing operating power generation.

Findings

Finding 1: **Decentralised energy can meet future electricity demand in Iran at a 13% lower cost than traditional centralised generation.**

TABLE 2: POTENTIAL CAPITAL COSTS AND DELIVERED ELECTRICITY COSTS SAVINGS THROUGH DE

	100% CG	100% DE	DE Saving	% Reduction
Capital costs (billion $)	40.7	35.3	5.4	13%
Delivered electricity costs ($c/kWh)	4.14	3.84	0.30	7%

WADE, 2007

Finding 2: **DE could reduce Iran's consumption of natural gas for power generation by 54 TWH per year through higher efficiency, allowing more of its resources to be used locally for other purposes, or to be exported.**

Lower gas consumption is achieved because gas CHP is more efficient than centralised gas power plants, because of the on-site use of the heat output of the generation process, which is otherwise wasted.

Finding 3: **The potential for oil and gas-fired CHP applications in Iran is considerable and can deliver concrete cost savings and emission reductions.**

The results show that developing the potential for oil and gas-fired cogeneration at industrial and commercial facilities can reduce electricity costs compared to the centralised Baseline Scenario. Realising one-third of this existing potential, electricity costs could be reduced by 17% from the baseline scenario.

Finding 4**: Because the DE scenario is cheaper overall it is a more cost-effective way of reducing emissions of carbon dioxide from electricity generation than a conventional centralised system with a large share of combined-cycle gas turbines.**

Costs are saved as decentralised generation is more efficient, because it avoids network losses by reducing transmission requirements, and allows for the combined use of the heat and power output. Lower transmission requirements also mean that less network is needed to deliver electricity to users, so that network investment costs are lower. In this study investment in the transmission and distribution networks to 2024 in the baseline scenario is $10.1 billion in a centralised system, but only $5.2 billion with decentralised generation.

Finding 5: **Demand side management measures can significantly reduce costs, emissions and fuel use.**

Demand growth is the single most important parameter. The demand growth sensitivity scenarios show that reducing the future demand growth to 2.4% per year through demand-side-management measures can reduce capital investment costs and fuel use significantly. Demand-side-management satisfies service needs by a range of measures, mainly through energy efficiency. Conversely, supply-side-management simply supplies more capacity to fulfil needs. CO_2 emissions are also reduced by 8.6% from the baseline scenarios.

TABLE 3: CAPITAL COSTS, CO_2 EMISSIONS AND GAS USE AND DEMAND GROWTH SCENARIOS (WADE, 2007)

Scenario	Capital costs (billion $)	CO_2 emission (Mt/yr)	Natural gas use (TWh/yr)
Baseline – CG	40.7	84.35	446
Baseline – DE	35.3	84.14	392
Low demand – CG	31.0	75.76	375
Low demand – DE	26.7	75.66	336
High demand – CG	69.9	110.67	665
High demand - DE	61.5	109.32	559

Summary

Iran can meet its anticipated energy needs at lower cost and with less pollution by incorporating decentralised energy generation, making greater use of its abundant renewable sources and by a shift in energy policy towards encouraging demand side management.

Over the next 20 years:

1. **Decentralised energy can meet future electricity demand in Iran at a lower cost than traditional centralised generation.**
2. **Decentralised energy is a more cost-effective way of reducing emissions of carbon dioxide from electricity generation than conventional centralised systems.**
3. **Meeting 20% of electricity demand in Iran with renewable sources in 2020 could reduce CO_2 emissions by 13% from a business-as-usual scenario.**
4. **Decentralised energy could reduce Iran's consumption of natural gas for power generation allowing more of its resources to be used locally for other purposes, or for export.**
5. **The potential for oil and gas-fired CHP applications in Iran is considerable and can deliver concrete cost savings and reduce emissions of greenhouse gases and other pollution.**

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