Global Relations Forum (GRF) is an independent, non-profit membership association committed to being a platform for engaging, informing and stimulating its members and all interested individuals in all matters related to international affairs and global issues. GRF intends to advance a culture that rewards the fertile tension between passion for intellectual diversity and dedication to innovative and objective synthesis. It nurtures uninhibited curiosity, analytic inquiry, rational debate and constructive demeanour as the elemental constituents in all its endeavors. It contributes to the shared understanding of and aspiration for humanity's path to peace, prosperity and progress as an accessible, inclusive and fair process for all. GRF does this in a variety of ways: by sponsoring task forces and policy reports; by convening meetings with prominent global leaders; by organizing roundtables with experts; and by fostering cooperation with global counterparts as well as through its seminar programs aimed at engaging young people in the global agenda. GRF also sees its website, **www.gif.org.tr,** as a vibrant forum towards achieving its goals.

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TURKISH ENERGY STRATEGY IN THE 21ST CENTURY:

WEATHERING UNCERTAINTIES AND DISCONTINUITIES

Task Force Report 2013

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Task Force Report
2013

GİFGRF

Co-Chairs

Fatih Birol, Gülsün Sağlamer

Project Director

Nigar Ağaoğulları

Global Relations Forum (GRF) is an independent, non-profit membership association committed to being a platform for engaging, informing and stimulating its members and all interested individuals in all matters related to international affairs and global issues.

GRF was founded with the enthusiastic support of 40 accomplished Turkish men and women who have assumed prominent roles in international fora and have received international recognition for their efforts throughout their careers. The founding members include former secretaries of state, university presidents, members of the armed forces, central bank governors, ECHR judge and retired ambassadors as well as leading business leaders, scholars, artists, and journalists. It was officially registered on May 11th 2009 and its first General Assembly was held on November 9th, 2009.

GRF intends to advance a culture that rewards the fertile tension between passion for intellectual diversity and dedication to innovative and objective synthesis. It nurtures uninhibited curiosity, analytic inquiry, rational debate and constructive demeanor as the elemental constituents in all its endeavours. It contributes to the shared understanding of and aspiration for humanity's path to peace, prosperity and progress as an accessible, inclusive and fair process for all.

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Task Force members reached a consensus on the framework and overall conclusions of this report. The members participated in the Task Force in their individual, not institutional, capacities. Thus, the views and opinions expressed in this Task Force report do not necessarily represent the views of their institutions.

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PRESIDENT'S NOTE

Energy policy is a complex corpus of distinct but intertwined policy processes. The challenge of thinking about energy policy is in disentangling and prioritizing these numerous policy questions and the key interlinkages among them.

In the absence of a manageable framework for addressing the numerous energy-related challenges, some of these disparate policy processes assume disproportionate significance in private and public debates, mostly driven by available expertise or political and economic agendas. Similarly, without a robust intellectual compass, it is virtually impossible to judge the relative importance of the incessant flow of news and developments that all ostensibly have a deep and lasting impact on the whole energy domain.

This Task Force report is first and utmost an attempt to build a coherent framework for the energy policy field that allows for a strategic assessment and prioritization of options in the face of political, economic, technical, security or environmental trends and discontinuities. GRF was very fortunate to bring together an exceptional group of experts and practitioners in tackling this formidable task.

Although the framework is mainly used to assess Turkish energy policy in the report, we hope the generality of the analysis will contribute to energy policy discussions beyond Turkey.

The paper divides the problem into three distinct areas, grouped mainly by central policy objectives: access to fossil fuels, use of new technologies in energy supply and demand, and managing nuclear power as a hybrid problem of access, technology and security. The overarching energy policy objectives of supply security, affordability and sustainability are addressed in relation to these three domains.

There are many interesting insights and observations in the report but I want to highlight four themes of systemic global relevance that I derive from the analysis.

The first observation is conceptual. Diversification of energy sources, suppliers, infrastructures is the conventional remedy against widespread uncertainty in managing energy challenges. The report emphasizes the pervasiveness of qualitative discontinuities in the energy context that cannot be addressed through simple diversification. Thinking in terms of options and flexibility is as important as diversification in designing energy policy. Structures for rapid demand shifts including inter-fuel substitutability, systemically built-in redundancies, and capacity for rapid scalability of new technologies are all necessary elements of the latter approach. These structural measures are essentially about creating the ability to make rapid adjustments in a nations' energy supply/demand profile when confronted by sudden shifts in the energy context.

The second reflection is less abstract and relates to the report's emphasis on "market structure" as the meta variable for strategic calculations in global oil and gas trade. The report duly notes that from the national supply security perspective of energy-importing countries, globally integrated markets provide a high level of supply security as long as global supply routes are safe and open to all. Fragmented and regional markets or bilateral trade generate interdependencies that can burden national economic and security calculations. Furthermore, fragmented energy markets tend to give disproportionate bargaining power to supplier nations.

Given this identification of oil and gas market structure as a core element in national energy security calculations, a systemic link emerges between fossil fuel market structure and national security reflexes of fossil-fuel importing countries. In the aggregate, fragmented markets are more likely to trigger defensive national security reflexes and the emergence of bilateral/regional interdependencies which can undermine or at least constrain broader global cooperation.

Within that context, the high volume of shale gas supplies and growing LNG trade provide a transformative opportunity in integrating global gas markets and carries the promise of weakening a core energy security concern across the world. It should be an overarching strategic priority to encourage this trend and to avoid policy barriers to natural gas trade. Similarly, the new oil supplies in the US and possibly in other geographies should not be allowed to engender a debate about regionalization of oil trade. US energy independence or regional self-sufficiency discourse is already eliciting regional security discussions and shaping defensive reflexes in other parts of the world. The global geometry of oil trade is a critical underpinning of the global security order and its fragmentation would have adverse repercussions that would go well beyond energy trade.

A third simple insight of the report also carries systemic importance in thinking about how the world can achieve a rapid pace in shifting away from the high carbon-emissions trajectory. The report notes the bifurcation of national policy interests in assessing low or no-carbon energy technologies. This dichotomy is shaped by two distinct vantage points: the nation as a consumer versus as a prospective global supplier of these technologies. The policy positions implicated by these two different viewpoints diverge in the willingness to support the deployment of these new technologies at a national level. The consumer nation mindset is understandably more hesitant about deployment of those technologies, is deterred by high upfront costs and lured by the prospect of decreasing prices in the future. The global supplier nation aspiration leads to a more active policy position about these technologies and views their deployment as an opportunity to build national technology, brand and global market share.

This is a structural tension in national policy-making that in the global aggregate serves as a strong head-wind in the drive for lowering carbon emissions through new technologies. It is a global systems problem. Increasing the investment in and deployment of new energy technologies around the world to reduce carbon emissions will require more nations to become economic stakeholders in the growth of the global market for these new technologies. Ensuring market access, managing the impact of national subsidies, encouraging international research and corporate partnerships, designing IP regimes and financing mechanisms conducive to cross-border partnerships should be part of an enlightened global drive to engage more nations as parts of the supply chains in new energy technologies. We need to mobilize wider resources, build higher demand and elicit policy enthusiasm for new energy technologies across the world to steer away from the current global high-carbon trajectory. That requires more stakeholders in that alternative future.

Finally, the Task Force's assessment of nuclear power is well-calibrated and thoughtful at the national level, and instructive at the global level. The report stresses the high upfront costs of nuclear power plants, hence the need for very long life-times to ensure economic feasibility. Any internationally induced disruption or premature termination of service due to a global safety or security discontinuity is a significant risk. Therefore, national nuclear power calculations cannot be considered in isolation from the long-term global nuclear safety and security risk context. To the extent that the broader global risk context is an integral part of a nation's assessment of its nuclear power prospects, building national intellectual and institutional capacity to improve that global context should be an essential part of any nation's nuclear policy plans.

The report concludes that informed, committed and responsible political engagement to alleviate safety and proliferation risks in the global nuclear power industry should be a central element of any national nuclear energy initiative. That is a very timely and relevant recommendation as nuclear energy may become more pervasive across the world in the coming decades. To invest in nuclear energy while being oblivious to associated global risks is neither advisable nor responsible as a policy alternative. The report's recommendation at the national level offers a sensible and responsible approach that can and should be generalized to the global scale.

Charting through a domain as complex and charged as energy is not an easy task. Keeping clear of platitudes, conventions and conditioned instincts demands intellectual determination, persistence and patience.

We are very grateful to each and every member of the Task Force for their time, dedication and the wise guidance they so generously provided.

We had the good fortune to benefit from the leadership of Dr. Fatih Birol and Professor Gülsün Sağlamer as Co-Chairs of the Task Force. As distinguished intellectual and institutional leaders in their professions, they brought crucially complementary competences to the Task Force. Their commitment and resolve were pivotal at every stage in not compromising the ambitions of this effort. We are deeply grateful for their confidence in what proved to be a long and demanding process.

Ambassador Sönmez Köksal was exceptionally generous with his time throughout the whole process, culminating in the tedious editing of the text in two languages. His erudition, command of linguistic subtlety, steady focus and unrelenting patience were truly inspiring. Professor Muhsin Mengütürk was a driving force from the conception of the idea to its completion. His committed intellect and consistently constructive inquisitiveness opened up new vistas for us at every step.

Last but not least, this project could not be completed without the personal ownership, persistence and patience of Ms. Nigar Ağaoğulları, who skillfully directed every stage of the Task Force process. Her drive to ensure GRF's contribution to the Turkish energy policy debate never wavered over the long course of this effort. More importantly, she maintained the collective momentum at each stage of the work with her diligence and good humor. Mr. Ali Serkan Türkmenoğlu, Senior Associate at GRF, played an essential role in the tedious editing process. We all benefited from his thoroughness, attention to detail and commitment to accuracy. I thank both of them for their dedication and the camaraderie they so naturally and generously offered throughout the process.

I hope this Task Force report will inform and advance Turkey's energy policy processes. I equally hope that the framework of analysis and the derived insights will be of relevance and value for energy policy thinking in other countries.

In retrospect, the one core principle I take away is that one cannot think about national energy policy without a workable understanding of the global energy context with all its dimensions. Seeking partial equilibrium national solutions to such a globally interlinked problem is almost certain to be futile and misguided. Around the world, we all need to think creatively about how to juxtapose and reconcile our national priorities with global imperatives. That, in the aggregate, should pave the way for a sustainable energy future for our civilization.

I hope this report will serve as GRF's first contribution to that effort and will be followed by many in the years to come.

Memduh Karakullukçu
GRF Vice-Chairman & President

CHAIRS' ACKNOWLEDGEMENTS

Convening a Task Force on Energy has been a critical undertaking for Global Relations Forum (GRF), especially at a time when our newly found, young institution was experimenting the limits, feasibility and purpose of instruments that would be our signature in the following years. It involved imagination, creativity, time dedication as well as uncertainty like the policy area itself. We now see that this Task Force was a very rational and timely initiative to position GRF as a reputable institution which takes responsibility to shape the global agenda.

As Co-Chairs of this Task Force, we are deeply grateful to the Task Force members who brought with them their divergent backgrounds and expertise. They participated in this study in their individual capacities; hence the views and opinions expressed in this report do not necessarily represent the views of their institutions. This report would not have been possible without the members' outstanding intellectual and time commitment. Our members made crucial and substantive contributions during the meetings we have held over the course of one year as well as throughout the drafting process. Ambassador Sönmez Köksal deserves special mention for offering his precious time, invaluable insights and diplomatic sensitivity in every walk of this process. His exceptional guidance, thoroughness and constructive suggestions were very kind and supportive in producing the final version of this report.

First and foremost, our earnest appreciation and gratitude go to Mr. Memduh Karakullukçu, GRF Vice-Chairman and President who provided exceptional leadership and commitment in drafting this report. His dedication, energy and resolve brought our meetings into consensus and this report into fruition. Without his intellectual vigour, it would be impossible to initiate and carry out this undertaking.

The purpose of this Task Force was to establish a conceptual structure, which would carry us from apparent contradictions among members' diverging viewpoints to policy alternatives, rather than to provide conclusive assessment. Accordingly, the parallel intent was to facilitate the reader an opportunity to approach and analyze the subject matter from different angles rather than dictating a set of policies. Hence, the report's framework can continue to develop and be of use to every individual reader, even as new information becomes available far into the future. This is a very complex and difficult task; yet, Memduh Karakullukçu's approach, which encompasses the whole framework and integrates relevant as well as seemingly irrelevant dimensions, has handled this synthesis process excellently.

This report immensely benefited from the invaluable wisdom of the following distinguished guests. We would like to extend our heartfelt thanks to Budak Dilli, Former General Director of Energy Affairs; Ambassador Hakkı Akil, Former Deputy Undersecretary of Ministry of Foreign Affairs; Dr. Nurşen Numanoğlu, Former Deputy Secretary General for EU Affairs; Luis Echavarri, Director-General of OECD Nuclear Energy Agency; Prof. Mehmet Karaca, Prof. Cem Soruşbay, Prof. Mete Şen, Prof. Zerrin Yılmaz, Prof. Sermin Onaygil from Istanbul Technical University; Dr. Selahattin Anaç, General Director and Chairman of Turkish Coal Association; Kausar Qazilbash and Hakan Irgıt from Accenture; Erdal Çalıkoğlu, Deputy General Manager of General Directorate of Electrical Power Resources, Survey and Development Administration, and Gökmen Topuz, Former Deputy General Manager of Zorlu Energy Investments who accepted our invitation and shared their knowledge and unique insights in their respective fields.

Last but not least, we would like to extend our appreciation and deep regards to Project Coordinator Nigar Ağaoğulları for her exemplary meticulousness and coordination. The youngest team member Project Assistant Ali Serkan Türkmenoğlu showed an excellent performance throughout the whole process. For technical issues Yücel Yeşer was always ready to make the things

running. They persistently offered amiable support and helped us in completing this demanding task through various stages. We are grateful for their cooperation from the outset.

To conclude, our journey was challenging but equally pleasant throughout this process. We are honored to be a part of this important study and commission.

Gülsün Sağlamer & Fatih Birol
Task Force Co-Chairs

TASK FORCE REPORT

PREFACE

Energy permeates every aspect of human activity. As such, all nations around the world strive and compete to ensure affordable, secure, sustainable access to energy for their citizens.

Given energy's significance to life, its wide reach and the vast number of interests involved, complexity is structurally ingrained.

Energy policy thinking is burdened with the challenge to streamline the incentives and the efforts of myriad actors in the midst of such complexity to ensure coherence in purpose.

Conceptual models are our best hope in guiding and aligning the numerous diverse actors through shifting winds of complexity. If we fail to develop intelligible models to convincingly capture the complexity that surrounds us, our ability to sail through it will be fundamentally compromised.

With the gravity of that challenge in mind, this Task Force report is intended as a modest contribution to understanding, clarifying and articulating the complexities of the energy debate in Turkey and in the world.

I- HIGHLIGHTS

- √ *Energy policies should be designed to withstand abrupt adverse shifts and to benefit from fast-moving favorable changes. Investing in options for flexibility and avoiding lock-ins should be overarching policy priorities.*

- √ *The Turkish economy is dependent on fossil fuel imports for its energy needs which impose a significant burden on the national accounts and exacerbate the economy's structural current account deficit challenge. Increasing indigenous production and improving energy efficiency are obvious policy objectives. However, building lasting structures of mutual benefit with resource-rich nations in the region, developing national competence in new energy technologies and achieving system flexibility that will allow for dynamic substitutability across energy sources based on cost advantage should also be key elements of the long-term strategy to manage the economic burden on the national economy.*

- √ *The Turkish economy's current relative energy efficiency and carbon intensity performance is not alarming, but the prospects are worrying. The present state appears to be the serendipitous outcome of unrelated policies, particularly in the transport sector, but not the methodical implementation of energy efficiency policies. Going forward, energy security and cost considerations as well as global political imperatives will demand more systematic energy efficiency and carbon emission policies.*

a) On Fossil Fuels

- √ *A structural shift in fragmented gas markets towards global integration is a probable, high-impact discontinuity. A structural shift in globalized oil markets towards non-market regional* *transactions is a low-probability, high-impact discontinuity. Both discontinuities would have a profound impact on national energy policies.*

- √ *Globalized energy markets limit the bargaining power of single nations as consumers or producers. Such markets provide liquid global pricing mechanisms and build on thriving commercially motivated infrastructures and actors. Fragmented energy markets, on the other hand, lead to political interdependencies, non-market pricing and the dominance of state actors.*

- √ *Turkey's indigenous lignite supplies generate an energy security driven policy bias in favor of increased coal consumption at the expense of natural gas.*

  However, higher volumes of Liquefied Natural Gas (LNG) trade and integrating gas markets improve the projected supply risk profile of natural gas relative to coal. At the same time, the possibility of a globally agreed carbon-pricing regime in the next 20 years would disadvantage coal relative to gas. Any policy preference in favor of coal should be recalibrated to take account of these critical discontinuities.

- √ *The evolution of the interdependence between the Russian Federation and the EU will be closely linked to the probable integration of global gas markets. As this change unfolds, it is highly likely to have repercussions for Turkey's transit role and access to Caspian resources.*

- √ *Iraq is a natural energy partner for Turkey in the context of both integrated and fragmented energy markets. A comprehensive framework for cooperation will allow both countries to benefit from vibrant energy markets. A broad framework for energy cooperation can include fossil fuel exploration and development, energy trade and transit as well as infrastructure development.*

- √ *To the extent that the LNG markets provide a reliable, diverse supply base, national gas supply security strategy should be guided by a clear, quantifiable rule. The medium-term* *objective for Turkey should be to achieve at a minimum the n-1 infrastructure standard provided that supply source risks are sufficiently uncorrelated.*

- √ *The increasing integration of gas markets is paving the way for more liquid, reliable spot gas pricing alongside the traditional oil-linked pricing. Turkish policy-making should take this shift into consideration in planning and shaping its gas purchase strategy. The current gas glut favors at least a partial shift to spot gas linked pricing. The shift can be achieved by renegotiating existing contracts or by opting for gas linked pricing in new purchase agreements.*

- √ *The need to consider the cost implications of the current market integration in gas is not about opting for lower spot prices. The issue is to prepare Turkey's gas purchase strategy to a fundamental shift in the global gas pricing mechanism. That preparation would entail a range of elements ranging from contract design to financial risk management operations.*

- √ *Increasing LNG trade allows Turkey to aggregate more diverse demand sources. At the same time, the current gas glut may gradually shift the bargaining balance away from national suppliers to private players in demand management. If these developments prove to be structural, the prospects for a more central role for Turkey in the global gas trade may become more viable. Such prospects should be guided and shaped by commercial interests as well as strategic considerations.*

- √ *There is a need to develop enhanced executive capacity in realistically pursuing national oil and natural gas supply strategies. Establishing the mechanisms of mutually reinforcing national strategy and executive capacity requires close coordination between the public and the private sectors. Institutionalizing such coordination through generic structures at the outset may face implementation difficulties and skepticism. Instead, the Task Force initially recommends two ad-hoc public-private cooperation committees to chart the roadmaps in two key areas of Turkish energy strategy:*

i. ***The Committee on Energy Cooperation with Iraq and the Region***

ii. ***The Committee on Turkey's Role in Natural Gas Trade***

These committees should be conceived of and shaped with the goal of establishing institutional mechanisms for closer coordination and cooperation between the public and the private sectors to serve Turkey's long term national energy strategies.

b) On New Energy Technologies (NET)

√ *Energy strategy and planning increasingly relies on energy technology policy as much as on political or economic considerations.*

√ *"Capacity for generating new energy technologies" and "capacity to absorb existing technologies" are two distinct components of the energy technology policy.*

√ *Turkish energy technology policy debate and institutions should be structured to clearly demarcate these two objectives. Intellectual and institutional discipline in maintaining clarity of objectives is critical for energy technology policy efficiency and impact.*

√ *NET generation and absorption entail uncertainty, longtime horizons, externalities, scale economies and even political resistance by the incumbent energy industries. In the absence of the public sector's involvement, guidance and policy support, most of these structural obstacles cannot be overcome. The government has to take a leading role in advancing NET.*

√ *Although the surge in NET investments is currently much below desired levels, the impending climate crisis and the prospects for carbon pricing policies around the world suggest an inevitably steep NET growth trajectory with "uncertain timing". Turkey still has time to position itself to benefit from this potential growth industry before it commences its steep ascent provided that it can* *execute a determined strategy to build up its NET manufacturing and knowledge sectors.*

- √ *Private players need as much certainty as possible given the long-term nature of NET investments. Authorities should strive to make their dynamic policy-making process as coherent and predictable as possible.*

  The policy process should clearly articulate its dynamic decision-making algorithm, produce and share revised data that will guide its decisions and inform investors about long-term infrastructure strategies.

- √ *Developing a Turkish NET sector is a technology and industrial policy objective and should be treated as such. Technology and industrial policy is first and foremost a systems problem. The policy framework should focus on national technology generation and commercialization structures and systems in the NET domain.*

  Given the nascent state of the Turkish NET industry, any national NET generation strategy should incorporate coherent mechanisms to facilitate and to encourage cross-border collaboration.

- √ *The Task Force recommends three new institutional structures to assume responsibility for addressing gaps in Turkish policy-making with respect to NET absorption and generation:*

  i. Center for Policy Consistency and Foreseeability *in NET Deployment to provide independent analysis for coherence and continuity in NET adoption policies*

  ii. Committee for Advancing the Turkish NET Industry *to serve as a coordinating body to advance Turkish NET knowledge and manufacturing sectors*

  iii. Unit for Regulation Design *to serve as a core professional body within the Ministry of Energy and Natural Resources*

(MENR) with an "exclusive" mandate to draft reliable and robust rules and regulations related to NET

c) On Nuclear Power

√ *Turkey's nuclear power strategy is justified on the basis of cost, enhanced security, carbon emission reductions and technology transfer. There is a legitimate debate on each one of these justifications.*

However, the current debate ignores potential global safety and proliferation crises that could create significant discontinuities in global nuclear power generation. That would upset all current energy security, cost and emission considerations.

√ *Mitigating safety risks is a multi-dimensional problem during both the operation and the decommissioning of nuclear facilities. An independent oversight/regulatory agency with sufficient funding and expertise should monitor every stage of the process.*

√ *Turkey has to invest intellectual and diplomatic capital in the global non-proliferation and safety effort as an integral part of its strategy to invest in nuclear energy. Turkey should become globally recognized as a responsible actor in international nuclear non-proliferation and safety debates and initiatives.*

√ *The Task Force recommends two new institutional structures to assume responsibility for addressing systemic gaps in Turkish policy-making with respect to nuclear power:*

i. Nuclear Research & Policy Center, *an independent policy institute to inform the official policy formulations and to make contributions to the global nuclear safety & security debate.*

ii. Unit for Nuclear Proliferation, *to be established within the Ministry of Foreign Affairs (MoFA) to "exclusively" engage in the international diplomatic efforts related to the international nuclear security regime.*

II- INTRODUCTION

Securing uninterrupted, affordable and globally sustainable energy lies at the core of national energy policies around the world. Motivated by these objectives, strategies and policies are formulated on increasingly sophisticated projections of the energy context's interlocking components. However, a key feature of the energy context is its notable capacity to take sharp turns in its evolution, which can frustrate projections and thus the policy choices. The large scale and long life-cycle of most energy investments introduce a pervasive structural lock-in effect that increases the cost of frustrated policy choices. Such costs, in turn, engender a systemic lock-in problem of entrenched policies.

Therefore, dealing with uncertainty in addressing energy access, affordability and sustainability is an overarching policy design challenge that cuts across national and temporal boundaries. This Task Force report is an attempt to formulate Turkish energy policy choices motivated and constrained by the inherent uncertainty of the complex global energy context.

Uncertainty permeates almost every aspect of the energy problem. On the supply side, technology and fortuitous geology can trigger unforeseen trajectories of resource expansion. Increased ability to extract unconventional gas and oil, ever-improving technical competence in deep-water exploration or even the emerging accessibility of the polar resources expand the potentially accessible fossil fuel base from the US to West Africa, from Brazil to the Arctic.

As leaps in technology and fortuity expand the resource base, unforeseen politics and policies may complicate and defer extraction. The international disputes over maritime territorial boundaries and Exclusive Economic Zones, ethnic conflicts, international political struggles that obstruct transnational oil and gas transportation, embargoes and international oligopolies can delay accessibility of otherwise available resources for years if not decades. Similarly, global awareness of the adverse environmental impact of fossil fuels shapes policies and may limit, defer or even prohibit the extraction of polluting fuels like coal and oil sands, or rule out deep-water drilling in some parts of the world.

The impact of political and technical uncertainty on energy supply is further exacerbated by economic fluctuations. Energy investments typically have long lead times so supply can respond to price signals with a significant lag generating structural price volatility.

Disruptions due to natural disasters, war, terrorist activity, or piracy can have a notably adverse impact on supply. Fossil fuels tend to be geographically concentrated and maritime chokepoints constitute a critical risk to the global energy supply system. Oil and gas pipelines, and national infrastructures are structural vulnerabilities with direct impact on supply.

The emergence of new energy technologies and policies supporting the deployment of those technologies represent a distinct and growing dimension of the global energy supply system. Research labs, energy start-ups, corporations and policy-makers around the world are all parts of a potentially disruptive technology scenario that is hard to predict in impact, much less in timing.

On the demand side, technology leaps motivated by energy security and/or environmental concerns can change the energy intensity of economies. The evolving habits and culture of societies contribute to the uncertainty in energy demand. Social awareness of and concern for local pollution or global warming modify energy consumption patterns and may reduce demand. It is hard to predict whether and at what pace the heightened social sensitivity to energy use will become a global norm.

Politics, policies, economics, investment cycles, technology, environmental concerns, and culture all play a role in the pervasive uncertainty of the global energy context.

Confounded by this context, policy-makers seek to reduce the uncertainty, where possible, and to create flexible structures that can withstand or benefit from unforeseen shifts in this broad context.

a) Core Uncertainties

For the purposes of this report, the discussion aims to disentangle what appear to be the major interlinked yet distinct undercurrents of uncertainty in the energy sector. The analysis is structured around three broad energy domains that can also be delineated based on distinct core uncertainties:

- Fossil fuels
- New energy technology generation and deployment (including renewables, efficiency and clean fossil fuel technologies)
- Nuclear power as a hybrid fuel/technology problem

Rather than listing myriad uncertainties in each of these areas, the report's approach is to determine core discontinuities that can qualitatively change the context of energy policies in each domain and to suggest mechanisms for weathering those shifts. Other uncertainties are addressed within this guiding framework:

i. Fossil fuel markets and "market structure discontinuity"

Fossil fuels are expected to dominate energy consumption for at least a few more decades. Security of access and price trajectory of fossil fuels will remain the core concerns of national energy policies in many countries during this period.

A wide range of geopolitical, economic and technical factors impacts the supply security and price dynamics of fossil fuels. The nature and extent of the impact shaped by these diverse factors is closely linked to the market structure of the traded commodity.

Security and price dynamics involved in integrated global markets are different from fragmented markets. Fragmented markets tend to have high levels of bilateral interdependency, long-term pricing schemes, transportation and investment lock-ins. Globalized markets, on the other hand, are characterized by diversity of supply, spot market pricing and flexible transport systems. Accordingly, the contexts for national energy strategies in fragmented and globalized energy commodity markets are distinct.

Traditionally, oil is traded in integrated global markets, whereas the natural gas market is fragmented. Coal markets are global, but high transportation costs generate a bias for regional trade.

The interplay of various dynamics in the energy domain determines the market structure of the traded commodity over time. The resulting market structure then determines the framework of political, economic, security, business dynamics that confront national energy policies. In a sense, market structure of oil, gas and coal is an intermediate meta variable that is shaped by a set of primary fundamental dynamics, and that in turn shapes another set of dynamics directly relevant to long-term national policy-making.

The report specifically addresses the increasing probability of a shift towards the global integration of natural gas markets. The report also entertains the possibility of the less likely scenario of a shift towards partial fragmentation of oil markets.

Such phase shifts in market structures will have broad repercussions for national energy policy planning and constitute the first core uncertainty and potential discontinuity for the coming decades addressed in this report.

ii. New energy technologies and "timing uncertainty"

In the longer term, increasing fossil fuel prices, national security considerations and global climate concerns dictate an overarching unidirectional shift in favor of new energy technologies, including renewable energy, conservation and new end-use technologies and Carbon Capture and Sequestration (CCS). However, the pace of cost reductions and technology leaps underlying this trend are hard to predict. National policies, carbon pricing, technical progress, fossil fuel prices, climate-related catastrophes, and the market scale of new initiatives will all affect the speed with which such technologies will be adopted. Globally, the timing of this unidirectional shift constitutes the second key source of uncertainty ("timing uncertainty") in the framework of this report. The pace and scope of new energy technology deployment is rife with discontinuities.

iii. Nuclear energy: "Global security and safety discontinuity"

Until new energy technologies achieve economic feasibility ("timing uncertainty"), nuclear energy will remain an attractive alternative both for energy security and environmental sustainability purposes. However, to the extent that a large number of new nations aspire to become nuclear energy states, the global safety risk will accordingly increase. Similarly the aspiration to develop local enrichment and reprocessing capabilities will significantly amplify the proliferation risk and may prove to be a major impediment to the trajectory of nuclear power around the globe.

The existing global security regime for nuclear energy increasingly appears to be inadequate for a rapidly expanding set of nuclear power nations. This fundamental global security concern should not be underestimated in global nuclear energy plans and projections. Similarly, safety risks may become a much more prominent element of the global debate as the number of nuclear power states increases.

Safety failures like Chernobyl, Three Mile Island, Fukushima or a security event that could be the "Chernobyl of proliferation" will almost certainly have a profound impact on the global nuclear safety/ security regime. Such incidences are likely to generate significant discontinuities in the global expansion of nuclear power and hence global energy supply.

National energy policies need to factor this global uncertainty into their strategic calculus. The global security and safety dimensions of nuclear energy constitute the third key source of uncertainty and potential discontinuity in the framework of this report.

b) Does Turkey Have a Role in Shaping Global Uncertainties?

The three core undercurrents of uncertainty described are globally shaped and determined. When thinking about national energy policy, it is important to judge whether Turkey has sufficient leverage or key assets to reduce the uncertainties or to direct the resolution of the uncertainties in its favor. To the extent that such leverage is inadequate, national policy should focus on designing and implementing energy systems that can withstand global qualitative shifts as described above.

Turkey is predominantly a fossil fuel consuming economy with some indigenous coal supplies, but a very high dependence on imported oil and gas. As a consumer, its market is sizeable, but not large enough to have an impact on global balances. Therefore, Turkey is neither a strategic energy producer nor a consumer. It is, however, a significant oil transit country with future potential and a potential gas transit country with increasing significance, neighboring countries with vast oil and gas resources. Most of the oil and gas producing nations in the region are constrained by domestic and international politics, which delays the full-blown emergence of Turkey as a systemically important oil and gas transit player. Nevertheless, Turkey's current transit state status and more importantly, its future potential is a key asset to be considered in its strategic planning.

With respect to the timing uncertainty of new energy technologies, Turkey does not yet possess key competences in renewable energy, efficiency or clean fossil fuel technologies. Looking forward, its economy does not yet have the requisite global scale to bring down costs through en masse launch of new technologies. Turkey is not ready to play a leading role in reducing or shaping the global time uncertainty in new technologies.

Turkey can invest in its intellectual and institutional competence in targeted technology assets that would gradually provide leverage in the technology driven energy transition of the global economy in the coming decades.

In the meanwhile, its focus should be on planning and undertaking flexible energy infrastructure investments that can facilitate the rapid deployment of new energy technologies as they become cost-competitive.

Similarly, Turkey does not yet have technical competence that it can leverage in nuclear energy. However, as indicated before, the possible discontinuity in nuclear power will be related to international safety and security matters. Turkish national energy policy should be designed to withstand the negative repercussions of a possible structural shift against nuclear energy internationally. In that context, Turkey's emerging role as a recognized regional player with the aspiration to be a responsible global actor could prove to be a key asset. Turkey may well assume a pivotal role in the design and, more importantly, in the diplomatic implementation of a globally safe and secure regime. Turkish energy policy with respect to nuclear power should therefore have a clear roadmap with respect to the global nuclear safety and security regime. Nations that intellectually and diplomatically invest in the global safety and security aspect of nuclear energy may be better positioned to weather possible safety and security discontinuities in the coming decades.

c) Why Do Core Uncertainties Matter for Policy Design?

The uniting quality of these three key uncertainties is the emphasis on possible discontinuities. The possibility of a phase shift in global fossil fuel market structures, the uneven bursts of progress and deployment among new energy technologies, and a structural reversal in the global expansion of nuclear power all include an element of discontinuity.

Framing the energy domain uncertainties in terms of major discontinuities rather than stable, well-quantified risks or at worst incrementally evolving probability distributions has implications for policy design. A policy response to discontinuities requires the design of energy systems that can withstand the major structural shifts outlined above. Energy policy should certainly be designed to address the familiar risks, but a strategic outlook should first and utmost be prepared to withstand key discontinuities.

Therefore, in anticipation of structural discontinuities, the persistent policy design priority throughout the report is on

i. creating options to achieve flexibility of low-cost, swift action when necessary

and

ii. avoiding lock-ins that would make agile policy shifts costly.

RECOMMENDATION 1:

Discreet structural shifts in trading regimes, the unpredictable pace of technological progress, and nuclear safety & security crises are inherent components of the energy domain. Energy policies should be designed to withstand abrupt adverse shifts and to benefit from fast-moving favorable changes. Investing in options for flexibility and avoiding lock-ins should be overarching policy priorities.

To achieve this end,

i-the public discourse should recognize this overarching theme and should not politically penalize decision-makers for investing in options that will frequently have upfront costs

but

ii-the costs of flexibility should be closely and independently monitored to prevent a carte-blanche for decision-makers' costly misjudgments.

The report situates the more traditional energy policies that pursue diversification of resources, suppliers, supply routes, and investment in different technologies within this framework. The portfolio approach underlying these traditional policies is highly useful in the absence of discontinuities, but needs to be complemented with strategies that can weather structural shifts.

After briefly introducing the Turkish energy sector, the Task Force report is structured around the three energy areas as delineated in this section. This organization also reflects a separation of the energy problem broadly into “access to fossil fuels”, “access to technologies” and “access to nuclear power” (a hybrid between fuels and technology).

III- TURKEY'S ENERGY DIAGNOSTICS: INTERDEPENDENCIES AND ASSETS

Evaluating Turkey's broad energy outlook is a necessary first step before addressing the interplay of various uncertainties in the global energy domain.

At the macro level, Turkey is highly dependent on imported fossil fuels for its energy needs. The energy bill imposes a significant burden on the national accounts and exacerbates the economy's structural current account deficit challenge.

As a general strategy, the obvious solutions to this structural and costly dependence are to increase indigenous energy sources and to reduce energy consumption through energy efficiency measures. Although there are efforts in both directions, the results have been modest.

Shifting the energy supply from an overwhelming dependence on imported fossil fuels to energy technologies like renewables and nuclear energy is another possible structural solution. However, to the extent that those technologies are not nationally generated but imported, new technologies may just shift the timing of external payments rather than reducing the total amount.[1]

The following discussion is structured to provide a context for the remainder of the report and broadly follows the outline described before. First, Turkey's fossil fuel based energy profile is described with particular emphasis on sources of supply. In the second part, energy and CO_2 intensity issues are addressed to motivate the need for efficiency, renewable energy and clean fossil fuel technologies. Measures related to Turkey's relative technical competence are provided in this context. Finally, a few important observations are shared about the context of Turkish nuclear energy.

1.The comparison in terms of import content across various energy sources should take into account the national share in both the upfront investment and the variable fuel costs.

a) Fossil Fuels

i. What is the extent of Turkey's dependence on fossil fuels?

Fossil fuels constitute the dominant energy source at 81% of total global primary energy supply.[2] This dominance is expected to decline but fossil fuels will remain the main source of energy well into this century. Even under International Energy Agency's (IEA) environmentally most ambitious scenario in World Energy Outlook (WEO) 2012, global fossil fuel use is projected to be 63% of the total in 2035. Given the aspirational assumptions of the scenario, the 63% level is likely to be a strict lower bound for 2035.

Turkey's fossil fuel share in its total primary energy use is 89,3%, notably higher than the global and OECD levels (Table 1). This is both a strong signal in favor of decreasing fossil fuel dependence in the long run and an important constraint to consider in Turkish energy policy planning in the short run. As shown in Table 1, fossil fuel shares are highest in resource rich regions and in the fast growing Chinese economy. Turkey, as a fossil fuel constrained nation, ranks paradoxically close to the resource rich regions.

Its oil use, as a share of its total primary energy supply, is less than the world average and significantly below the OECD level (Table 1). This is mostly a reflection of the relatively low current stock of vehicles compared to OECD levels (Figure 1).

2. IEA (2012), *World Energy Outlook 2012*, OECD/IEA, Paris (*"WEO 2012"*). The reported values reflect the levels in 2010.

TABLE 1

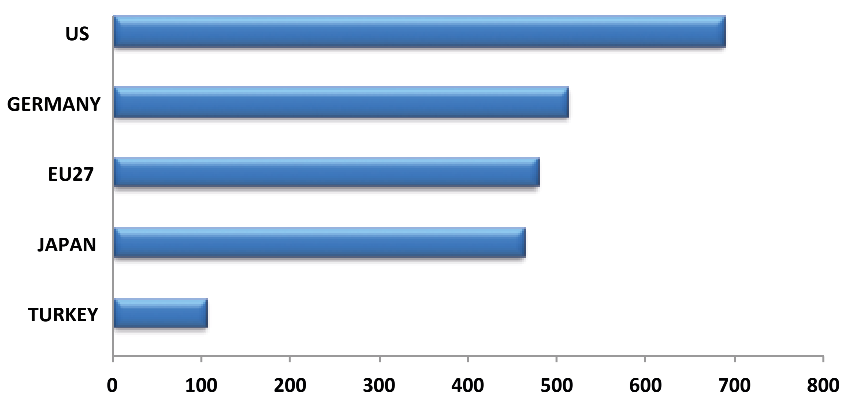
Fossil Fuel Dependence (as of 2010)

(% in Primary Supply)

	Fossil Fuels	Coal	Oil	Gas
Middle East	99,68%	0,32%	49,04%	50,32%
Russia	90,56%	16,20%	19,58%	54,79%
Turkey	89,30%	30,70%	26,70%	31,90%
Eastern Europe/Eurasia	89,09%	19,00%	19,61%	50,48%
China	87,50%	66,31%	17,38%	3,81%
US	84,19%	22,72%	36,36%	25,11%
OECD Americas	83,49%	20,10%	37,50%	25,89%
OECD Asia Oceania	83,15%	27,08%	38,65%	17,42%
Non-OECD Asia	81,86%	51,68%	21,98%	8,21%
Japan	81,29%	23,14%	40,85%	17,30%
World	81,12%	27,29%	32,31%	21,52%
OECD	80,75%	20,10%	36,29%	24,37%
Non-OECD	80,45%	34,25%	25,79%	20,41%
OECD Europe	75,67%	16,71%	33,42%	25,53%
EU	75,36%	16,40%	33,22%	25,74%
India	72,65%	40,96%	24,02%	7,67%
Latin America	68,77%	3,75%	43,69%	21,33%
Brazil	53,82%	5,34%	39,69%	8,78%
Africa	50,29%	16,23%	21,59%	12,46%

Sources: WEO 2012 & Republic of Turkey Ministry of Energy and National Resources, 2010 Energy Balances

FIGURE 1: Car Ownership (per 1000) Inhabitants



Sources: IEA & Republic of Turkey General Directorate of Highways, 2011

The relatively small size of the vehicle stock can be partially explained by the country's lower level of prosperity, but the high taxes on gasoline and diesel have also been a limiting factor in Turkish car ownership[3 4]. Although the current tax regime restrains demand for cars, increasing prosperity in the coming decades is almost certain to boost car ownership. The associated higher demand for oil is a key issue to consider for energy policy planners.

On the other hand, Turkey's use of coal in its primary energy supply, while only slightly above the world average, is notably higher than the OECD levels. As coal is the only significant indigenous fossil fuel resource in Turkey, energy security concerns partially explain higher reliance on coal. However, unlike China and India, which have 66% and 41% coal shares in their energy supplies respectively, Turkey's reliance on its indigenous resource base has been more measured.

There is currently an emerging tendency among policy-makers to increase coal's share significantly in Turkey's primary energy supply. The targeted rise in coal's share to 37% by 2020[5] will squarely conflict with the CO_2-emissions driven global stance against coal and may face international political opposition. Increased reliance on coal may be justified as a delayed convergence towards other big players like China and India, but it will be a politically strained argument if most big players gradually decrease the role of coal in their primary energy supplies (Table 2).

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3. Tax rates on gasoline at 60% are the highest within the OECD (IEA (2010), *Energy Policies of IEA Countries: Turkey 2009 Review,* OECD/IEA, Paris, *("IEA Turkey 2009 Review")*, p. 58). Although the high rates are mainly motivated by fiscal objectives, they can proxy as a very progressive selective carbon tax that is widely discussed but resisted around the world.
4. Tax rates on diesel were reported to be at 49%, which are only second to Norway among OECD countries, *IEA Turkey 2009 Review*, p. 58.
5. *IEA Turkey 2009 Review*, p. 151.

TABLE 2

Fossil Fuel Dependence 2020 - Projected

(% in Primary Supply)

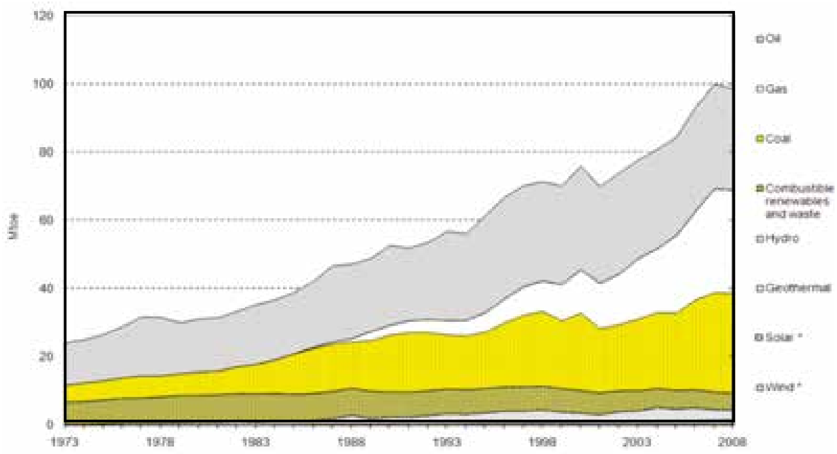
	Fossil Fuels	Coal	Oil	Gas
Middle East	98,52%	0,37%	46,86%	51,29%
Russia	89,20%	16,08%	20,23%	52,89%
Turkey	86,50%	37,00%	25,80%	23,70%
Eastern Europe/Eurasia	88,01%	18,15%	20,17%	49,69%
China	85,88%	61,04%	17,65%	7,19%
US	81,23%	22,00%	33,35%	25,88%
OECD Americas	80,74%	19,26%	34,28%	27,21%
OECD Asia Oceania	81,05%	27,77%	34,02%	19,27%
Non-OECD Asia	82,23%	51,58%	20,90%	9,75%
Japan	80,96%	23,43%	37,45%	20,08%
World	80,22%	28,81%	29,62%	21,79%
OECD	78,31%	19,67%	32,88%	25,76%
Non-OECD	80,55%	35,55%	24,68%	20,31%
OECD Europe	73,30%	16,27%	30,23%	26,81%
EU	72,55%	15,68%	29,84%	27,04%
India	77,00%	47,19%	22,21%	7,60%
Latin America	67,68%	4,77%	40,66%	22,25%
Brazil	53,69%	6,53%	36,36%	10,80%
Africa	51,62%	16,09%	21,25%	14,29%

Sources: WEO 2012 & IEA Turkey 2009 Review

Finally, the share of natural gas in Turkish primary supply is one of the highest among nations that do not have indigenous gas resources. This is a reflection of a key policy decision in the 1990s to introduce gas into the Turkish energy mix, mainly a consequence of the diminished unease about energy dependence on neighbors in the aftermath of the Cold War. Natural gas rapidly became a major component of Turkish energy supply within a decade (Figure 2).

The projected decrease in the share of natural gas in Turkey's primary energy supply to 23,7% by 2020 (Table 2) in favor of an increase in the share of coal may best be interpreted as a reflection of changed risk perceptions. Natural gas imports from a very limited number of

FIGURE 2: Total Primary Energy Supply, 1973 to 2008



* negligible

Source: Energy Balances of OECD Countries, IEA/OECD Paris, 2009,
cited in *Turkey 2009 Review*, p. 14.

neighboring suppliers create risky interdependencies. However, this risk should be re-assessed and re-calibrated within the context of a possible phase shift in global gas markets, as discussed in the next section.

FINDING 1:

Turkey is a heavily fossil-fuel dependent economy above and beyond the world average.

Its use of coal is less than economies similarly endowed with indigenous coal supplies, whereas its use of natural gas is higher than economies similarly not endowed with indigenous gas supplies. There is an emerging political consensus to change this composition by increasing the share of coal at the expense of natural gas.

Turkey's oil consumption in its primary energy use is moderate and notably less than the world and OECD averages, a trend aided by high taxation of oil and oil products. However, the current low level of car ownership is expected to rise rapidly with increased prosperity and as such can put significant upward pressure on the country's oil consumption.

ii. Is Turkey an important global player in fossil fuels?

Turkey's indigenous oil and natural gas production is very limited. It imported 93,4% of its oil and oil products supply[6] and 98,2% of its gas supply in 2011. It has access to indigenous coal supplies and imported only 26% of its coal needs in 2011.[7]

Turkey is clearly not a global energy player as a producer. Its share in global oil, gas and coal production is marginal (Table 3).

TABLE 3			
Turkey's Role in Global Fossil Fuels (as of 2011)			
(% Global Total)			
	Production	**Consumption**	**Turkey's Total Imports / Global Exports**
Oil and oil products	0,06%	0,8%	1,1%
Natural Gas	0,02%	1,4%	4,3%
Coal	1,00%	1,4%	2,1%

Sources: Republic of Turkey Ministry of Energy and National Resources, 2011 Energy Balances & BP Statistics 2012 & EIA International Energy Statistics 2011 & Eni World Oil and Gas Review 2012

Its consumption of oil, gas and coal were 0,8%, 1,4% and 1,4% of global supply in 2011 respectively (Table 3). As of 2011, its primary energy consumption in oil, gas and coal positions it as the 28th, 19th and 13th largest national market, respectively[8]. It is not among the top energy consumers.

The share of its imports in the global energy trade is another measure of its possible leverage in the energy domain. As of 2011, its purchases of oil, gas and coal constitute 1,1%, 4,3%, 2,1% of global trade in these commodities, respectively (Table 3). Its share in the oil and coal trade is not large, but it is the 8th largest natural gas importer[9].

6. The share of indigenous supply is calculated based on total local supply and gross imports. However, Turkey is also an exporter of oil products and the share of indigenous supply using net import levels was 92,3% in 2011.
7. Based on statistics taken from the website of Republic of Turkey Ministry of Energy and National Resources, 2011 Energy Balances, available at www.energy.gov.tr.
8. BP (2012), *Statistical Review of World Energy 2012*, BP, London *("BP Statistics 2012")*.
9. Ibid.

Its share in the natural gas trade is particularly important because gas markets are still fragmented; the buyer and the seller are typically locked in through pipelines and long-term bilateral contracts.

Table 4 shows the mutual interdependence between Turkey and its natural gas suppliers. The share of the three pipeline gas suppliers, the Russian Federation, Iran and Azerbaijan in overall Turkish gas supply is overwhelming. However, it is also important to note that Turkey's share of Russian gas exports is over 10% and that Turkey is the dominant buyer of Iran and Azerbaijan gas exports. Azerbaijan's geographic constraints and Iran's political constraints are important factors in explaining Turkey's dominant role in Azeri and Iranian exports. Turkey's existing pipeline based natural gas trade creates significant bilateral interdependencies with its suppliers.

TABLE 4

Turkey's Trade Interdependencies in Natural Gas (as of 2011)

	Share of Country in Turkish Imports	Share of Turkey in Country's Total Exports
Russia	56,2%	10,6%
Iran	20,1%	92,3%
Azerbaijan	9,1%	55,7%
Algeria	9,6%	7,8%
Nigeria	3,1%	5,0%
Qatar	1,4%	0,5%
Egypt	1,0%	4,7%

Sources: BP Statistics 2012 & The State Statistical Committee of the Republic of Azerbaijan

FINDING 2:

Turkey is not a major global energy actor as a producer or consumer of fossil fuels. However, it is an important natural gas client in its region. The current fragmented nature of the natural gas market narrows the available supplier base and creates strong bilateral energy interdependencies with the Russian Federation, Azerbaijan, Iran and potentially with Iraq and Egypt.

iii. Is Turkey an important energy transit country?

Turkey is well-positioned to be a transit country in energy trade. Its geography provides access to the Mediterranean basin for Russia, the Caspian nations, Iran and Iraq. As of 2011, the Russian Federation, Turkmenistan, Kazakhstan, Azerbaijan, Iran and Iraq claimed 25,3% of proven oil reserves and 52,2% of proven natural gas reserves[10]. These countries produced 24,9% of the global oil and 26,1%[11] of the natural gas in 2011[12].

In oil, Turkey serves as a transit country through the Straits and two international pipelines. The Straits mainly carry Russian and increasingly Caspian oil. The Baku-Tbilisi-Ceyhan (BTC) oil pipeline mainly carries Azeri oil, but Kazakh oil is also transported through this route. The Kirkuk-Ceyhan pipeline transports Iraqi oil.

The Straits still constitute the main element of Turkey's transit role. 2,9 mb/d crude oil and oil products flowed through the Straits in 2010[13]. On the other hand only about 1,1 mb/d[14] was transported through the two pipelines in 2010. The full capacity of the two pipelines is 2,8[15] mb/d.

In total, 4 mb/d of crude oil and oil products were traded through Turkey in 2010, which represented 5,9% of daily global oil trade[16]. Thus, Turkey is already an important oil transit nation.

Looking ahead, the growth of Turkey's oil transit role will depend on two factors, transit capacity and neighboring oil supply that will flow through Turkey. Given the safety concerns and the congestion, the

10. *BP Statistics, 2012*.
11. The discrepancy between the share of proven gas reserves and gas production is mainly a consequence of low production in Iran and Turkmenistan.
12. *BP Statistics, 2012*.
13. U.S. Energy Information Administration (EIA) Turkey Analysis, available at www.eia.gov, last updated on February 1, 2013.
14. Turkish Petroleum Pipeline Corporation (BOTAŞ); Turkish Petroleum Corporation (TPAO).
15. TPAO; *WEO 2012*, p. 396.
16. EIA reports crude oil trade as 43,7mb/d and oil products trade as 23,7mb/d in 2010. Trade through Turkish Straits and the two pipelines represent 5,9% of the total international crude and oil products trade (EIA International Statistics).

Straits are unlikely to sustain higher volumes of oil transit [BOX 1]. Therefore, expanding Turkey's oil transit role will require an increase in pipeline capacity.

In terms of new transit demand, the Russian Federation, the Caspian region, Iraq and at some point Iran are the potential suppliers. The Russian Federation has been diversifying its export destinations and export routes.[17] It has directed its increasing oil exports to its Baltic and Arctic ports. Its Black Sea exports have effectively remained constant over the last decade. With its new investments in the ESPO pipeline to the Asian markets, the Baltic Pipeline System II to its Baltic Coast and further Arctic shipments to Asia, the Russian Federation is unlikely to seek new transit capacity through Turkey.[18]

Transit demand may also originate from the Caspian states, mainly Kazakhstan, which is projected to require new export capacity after 2015 and may need 2 mb/d capacity by 2025[19]. A share of that export volume is likely to go through the Black Sea or across Anatolia. Given the environmental and safety concerns in the Straits, the added export volumes will have to pass through new pipelines to reach the Mediterranean. Samsun - Ceyhan, Bourgass - Alexandroupolis pipelines, and the expansion of current Baku-Ceyhan pipeline are alternative solutions to be considered. The Russian Federation's strategic priorities and leverage over Kazakhstan are likely to play a role in determining the extent of Turkey's transit role for Kazakh oil.

The Iranian case is significantly more complicated. The time horizon for new investments in and enhanced export capacity of the Iranian oil industry are highly uncertain due to international political considerations. Turkey is unlikely to play a transit role for Iranian oil in the near future, but should be ready to cooperate with Iran and the international community when the opportunity arises.

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17. *World Energy Outlook 2011*, OECD/IEA, Paris (*"WEO 2011"*), p. 302.
18. Vatansever, A. (2010), "Russia's Oil Exports: Economic Rationale versus Strategic Gains", *Carnegie Papers, Energy and Climate Program,* No. 116, December 2010.
19. *World Energy Outlook 2010,* OECD/IEA, Paris ("*WEO 2010*"), p. 512.

Finally, Iraq's oil production is projected to increase from 2,7 mb/d in 2011 to 6,1 mb/d in IEA's central scenario for 2020[20]. The share of Iraqi oil exports that will go through Turkey is uncertain at this point although expansion of Turkish routes provides promising options.

FINDING 3:

Turkey is currently an important oil transit country. Expansion of its oil transit role in the coming decades will depend on the increase in Iraqi and Kazakh oil production as well as strategic negotiations that will involve the Russian Federation and other related countries.

In natural gas, Turkey is not a significant transit country yet. Its gas grid is connected to several neighboring countries including the Russian Federation, Iran, Georgia-Azerbaijan and Bulgaria with a pipeline capacity for imports at 63,9 bcm[21]. Turkey also has a separate gas pipeline linking it to Greece for exports. However, gas exports to Greece have remained at modest levels (around 0,7 bcm in 2010 and 2011)[22].

Although there are numerous prospects for pipelines passing through Turkey that could link natural gas supplies in Azerbaijan, Iraq, Turkmenistan, Egypt or even Iran to the European markets, political calculations frequently override and delay commercial judgments. With the exception of the Russian Federation, all the supplier nations around Turkey are geographically or politically constrained. Their willingness and ability to export their gas supplies to European and world markets through Turkey is rife with uncertainty. Turkmenistan has rich gas reserves and its gas production is expected to rise with the enhanced reserves in Galkynysh field[23]. However, it is

20. *WEO 2012*, p. 429.
21. U.S. Energy Information Administration (EIA) Turkey Analysis, available at www.eia.gov, last updated on February 1, 2013.
22. Based on statistics taken from the website of Republic of Turkey Ministry of Energy and National Resources, 2010 & 2011 Energy Balances, available at www.energy.gov.tr.
23. *WEO 2012*, p. 137.

landlocked and its exports are growing mainly thanks to the Central Asia Gas Pipeline to China. The legal complexities of Trans-Caspian transportation provide ample opportunity for competing interests to delay the flow of Turkmen gas to Europe through Turkey. Iran is politically constrained and under severe international sanctions. Iraq is slowly recovering from its recent turmoil and is unlikely to have gas supplies for exports until the end of the decade.[24]

The most promising supply source for Turkey's gas transit role in the near future is Azerbaijan's Shah Deniz II gas field. Turkey and Azerbaijan signed an intergovernmental agreement in 2012 to build a pipeline across Anatolia (Trans-Anatolian Gas Pipeline-TANAP) with an initial capacity of 16 bcm per year to transport Shah Deniz II gas to Turkey's European border. The pipeline route that will connect TANAP to European markets at the Turkish border remains undecided. The two contenders are the Nabucco West pipeline connecting to Austria via Bulgaria, Romania, Hungary and the Trans-Atlantic Pipeline connecting to Italy via Greece and Albania.

FINDING 4:

Turkey is geographically well-positioned to be an important natural gas transit nation. However Turkey is not a significant natural gas transit nation yet. Its initiatives to become a transit nation are intricately entangled with the turbulent politics of the Caspian region and the Middle East as well as that of Europe, the Russian Federation and the US.

BOX 1: THE STRAITS

Istanbul and Canakkale Straits constitute an important element of Turkey's current energy transit nation status. However, given the safety and environmental concerns, there are clear limits to maritime traffic that can pass through these waterways.

24. *WEO 2012*, p. 484.

The Strait of Istanbul is approximately 31 km long with a width that ranges between 700 m to 1500 m. It is characterized by sharp turns where ships, depending on their size, may have to alter course over 12 times up to 80 degrees. Canakkale Strait is about 70 km with a width ranging between 1300 m to 2000 m and shares similar geographic characteristics.

The number of ships passing through the Straits has been increasing at a high rate. The number has risen from 4.500 in 1938 to 50.000 today. Notably, the number of oil tankers and other dangerous cargo vessels rose from 4.248 in 1996 to 10.153 in 2010. The amount of hazardous cargo increased from 60,1 million tons to more than 145 million tons in the same period. The expansion of maritime traffic through the Straits, especially in oil and hazardous cargo, is dramatic.

The current local maritime traffic in Istanbul also includes 2,5 million citizens who use the waterway on a daily basis for commuting and other purposes.

The physical limitations and geographic characteristics of the Straits establish a natural limit to the volume of transport that can pass through without endangering human life and the marine environment. Furthermore, a collision or an environmental disaster could lead to a closure of the Straits, which would adversely affect both the global energy trade and the goods trade involving Black Sea countries. This could prove to be particularly important during periods of tight global oil supplies. The Straits are among the natural bottlenecks and vulnerabilities of the global energy system.

In response to the threat of a large-scale accident, Turkish authorities introduced safety measures in 1994, which were revised in 1998. Traffic separation schemes were introduced in accordance with the "International Regulations for Prevention of Collision at Sea". The scheme was approved by IMO in 1995. Later a new vessel traffic services system was introduced in 2003 to further increase the level of safety.

The Montreaux Convention of 1936 established, in principle, the regime of free passage through the Straits. However, that basic principle is applied within the more fundamental constraints of human safety and environmental protection. The number of

collisions has indeed decreased dramatically after the enactment of the regulations.

The Straits are an important element of Turkey's energy transit role and also of the global energy system. Turkish authorities implement requisite regulations to ensure local safety as well as global energy security. Going forward, the geographic limitations combined with such legitimate concerns impose a natural constraint on the volume of energy trade that can pass through the Straits.

b) New Energy Technologies

i. Does Turkey have an energy-efficient economy?

Energy efficiency is a policy goal that serves all national energy objectives: security of supply, cost savings and CO_2 reduction. However, improvements in energy efficiency have, in most cases, upfront investment costs in buildings, cars, appliances, power plants and industry. Such large and pervasive investments need to be rationally considered, prioritized and sequenced in national policy design.

In 2010, Turkey's primary energy use per GDP generated, i.e. energy intensity, was 0,12 toe/1000 USD[25] on PPP-adjusted basis. This level compares favorably with the corresponding values for the world, the OECD, EU and the non-OECD (Table 5). Based on the PPP-adjusted measure, Turkey's energy efficiency also compares well with economies that have similar GDP/capita levels as reported in Table 5.

When energy intensity is measured based on GDP at market exchange rates, Turkey's performance lags behind OECD averages but it is still better than many of its peers at similar levels of economic development (Table 5).

25. These energy intensity values are reported by the IEA at PPP adjusted 2005 USD values.

Nevertheless, the current state of energy intensity performance conceals serious structural risks going forward. Turkish heavy industries like cement, steel and chemicals are not particularly efficient and there is significant potential for efficiency gains[26]. Industry's share of final energy consumption was 28% in Turkey compared to 22,5% in OECD economies in 2010[27].

The other risk is the anticipated increase in car ownership. Despite a recent expansion in car ownership, car density was still 103 per 1000 inhabitants in 2010 compared to 475 in EU-27.[28] The high taxation of cars, gasoline and diesel serves as a significant constraint in the transport sector. The car fleet is not particularly energy efficient, but its size is artificially held back by tax policies, thereby restraining the transport-related energy consumption in Turkey. However, the projected growth of the Turkish economy will almost certainly generate a rapidly increasing demand for automobiles. If the demand growth due to increasing prosperity is coupled with a shift to lower taxes on automobiles and fuel, the rise in car ownership could be dramatic. That would lead to a rapid deterioration in energy intensity levels.

Possible remedies to preempt an adverse trajectory in energy intensity levels due to increased levels of car ownership include adopting measures like improved fuel efficiency standards and incentives for mass transportation.

Although Turkey's energy intensity performance is not alarming at present, increasing national energy needs and the resulting carbon emissions demand a more systematic energy efficiency drive across sectors.[29] Energy intensity is primarily an energy security concern

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26. IEA (2009), *Implementing Energy Efficiency Policies: Are IEA Countries on Track?*, OECD/IEA, Paris (hereinafter referred to as *IEA IEEP 2009*); *IEA Turkey 2009 Review*, p. 45.
27. Based on statistics taken from the website of Republic of Turkey Ministry of Energy and National Resources, 2010 Energy Balances, available at www.energy.gov.tr; *WEO 2012*, p. 556.
28. IEA; Republic of Turkey General Directorate of Highways, 2011.
29. *IEA IEEP 2009*, pp. 108-109.

and should be treated on par with broader long-term supply security objectives.

Moreover, energy efficiency is increasingly a policy priority for many nations around the world. To maintain its current relative international performance in the coming decades, Turkish authorities need to plan ahead for necessary improvements in energy efficiency.

FINDING 5:

Turkish economy's energy efficiency performance is not alarming. However, this result appears to be a serendipitous outcome of unrelated policies, particularly in the transport sector, not methodical implementation of energy efficiency policies.

Energy security considerations and the global political responsibility to maintain relative energy intensity performance will demand more stringent and systematic energy efficiency policies.

TABLE 5

Energy and Carbon Intensity - Turkey's Relative Position (as of 2010)

	TPES/Pop** (toe/capita)	CO2/Pop (t CO2/capita)	TPES/GDP* (toe/000 2005 USD)	CO2/GDP* (kg CO2/ 2005 USD)	TPES/GDP (toe/000 2005 USD)	CO2/GDP (kg CO2/ 2005 USD)
World	1,86	4,44	0,19	0,44	0,25	0,60
OECD	4,39	10,10	0,15	0,34	0,14	0,33
NON OECD	1,19	2,88	0,20	0,50	0,66	1,59
EU 27	3,31	7,15	0,14	0,30	0,17	0,38
Turkey	1,44	3,65	0,12	0,29	0,19	0,47
China	1,81	5,43	0,26	0,78	0,60	1,80
India	0,59	1,39	0,18	0,43	0,56	1,30
Denmark	3,47	8,48	0,11	0,26	0,08	0,18
Italy	2,81	6,59	0,10	0,24	0,10	0,23
Spain	2,77	5,82	0,10	0,22	0,11	0,23
Portugal	2,21	4,53	0,10	0,21	0,12	0,25
Korea	5,12	11,52	0,19	0,43	0,25	0,55
Taiwan	4,71	11,66	0,15	0,36	0,24	0,61
Hungary	2,57	4,89	0,15	0,29	0,23	0,45
Poland	2,66	7,99	0,15	0,46	0,27	0,80
Chile	1,81	4,08	0,13	0,30	0,22	0,50
Uruguay	1,24	1,92	0,10	0,15	0,18	0,27
Russia	4,95	11,16	0,35	0,79	0,77	1,75
Brazil	1,36	1,99	0,14	0,20	0,24	0,35
Mexico	1,64	3,85	0,13	0,30	0,19	0,45
Argentina	1,85	4,21	0,13	0,29	0,29	0,67
Malaysia	2,56	6,51	0,19	0,49	0,42	1,08

Sources: IEA Key World Energy Statistics 2012 & www.iea.org/stats (for NON OECD and EU 27 countries, as of 2009)

***PPP adjusted 2005 USD values**

****population**

ii. *Does Turkey have a CO_2-efficient economy?*

The carbon intensity of the Turkish economy compares well with the world, OECD and non-OECD averages on PPP-adjusted basis. In 2010, Turkey emitted 0,29 kg of CO_2 per 1000 USD of GDP (Table 5). This level is slightly higher than the EU average and most EU countries. However, it is significantly lower than countries with similar GDP/capita levels, with the exception of Latin American economies. The corresponding values without the PPP adjustment are less favorable where Turkey's performance lags well behind Western European nations.

Turkey's carbon emission values by sector provide some clues about the dynamics behind its relatively good carbon intensity performance. Carbon emission shares of the power and transport sectors are below World, OECD and EU averages, but the building and industry shares are higher. Relatively low car ownership and the pervasive use of LPG vehicles[30] may explain the low share of the transport sector in emissions. Turkey's significant shift from coal to gas powered plants since the 1990s has certainly played an important role in the power sector's improved carbon performance.

In the absence of a strong renewable energy drive and a transformation in the manufacturing industry, the projected increase in coal-powered electricity generation is likely to harm Turkey's carbon intensity performance and lead to a further divergence from OECD countries. Supply security concerns with respect to coal will have to be weighed against carbon emission objectives.

FINDING 6:

The Turkish economy's current carbon intensity level compares well with World and OECD averages on PPP-adjusted basis. This is mainly a consequence of the high share of natural gas in power generation and the low level of car ownership. As there is no alarming carbon emission profligacy, Turkish investments in low carbon intensity initiatives are likely to be unhurried.

Looking forward, supply security concerns and the cost trajectory of carbon efficient technologies will be critical in determining the evolution of Turkish carbon intensity levels in the coming decades.

30. Turkey is among the top LPG vehicle markets in the world. The Turkish Statistical Institute (TSI) reports that 40,6% of all cars are LPG powered. Carbon emissions from LPG-powered cars are typically lower than gasoline-powered ones.

iii. Does Turkey have significant new energy technology assets?

New energy technologies have two related but distinct dimensions:

i. Technology Generation: The national capacity to take part in the global manufacturing of new energy technologies

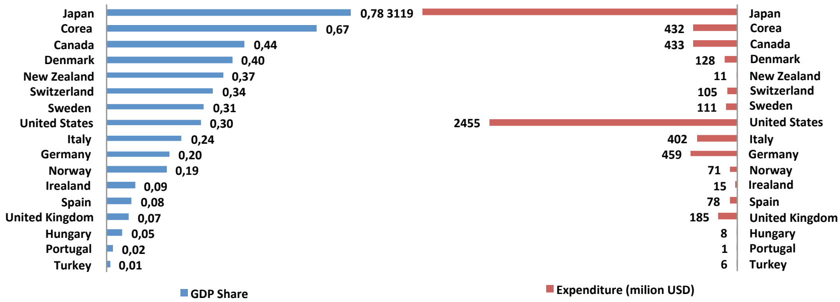
ii. Technology Absorption: The ability to acquire and deploy new energy technologies rapidly, reliably and cost-effectively.

Turkish policy initiatives, or even discourse, do not demonstrate a clear intent to take part in the new global energy technology generation as a strategic goal. Given the size of investments and the uncertainties involved in these new technologies, public funding support, public-private cooperation and targeted cross-border collaboration are essential. Those issues have not yet surfaced as part of coherent policy discussions.

There is no comprehensive national strategy to build RD&D capacity and human capital that will facilitate and expedite the emergence of a new energy technologies industry. Turkish public support for energy technology RD&D is very limited. Public R&D spending as share of GDP is reported to be the lowest among OECD nations[31] (Figure 3).

31. IEA reports Turkish low-carbon RD expenditure in 2008 at 6m USD but it appears to omit TÜBİTAK's (National Research Council) Energy Institute budget. Although the energy RD budget is small, the reported figures appear to understate the already low level; IEA (2010), *Energy Technology Perspectives 2010*, OECD/IEA, Paris (hereinafter referred to as *ETP 2010*), p. 477.

FIGURE 3: Low-Carbon Energy R&D Expenditure in IEA Member Countries



Sources: Turkey 2009 Review, p. 138
& IEA Energy Technology Perspectives 2010, p. 477.

The existing energy related RD&D is dispersed across research institutes and various university departments. Private sector's RD&D investment in new energy technologies is also limited.

On the technology transfer and deployment front, feed-in tariffs, purchase obligations for electricity retailers, and grid integration issues are addressed by new policies and regulations.[32]

FINDING 7:

At this stage, Turkish policy on new energy technologies displays some support for the acquisition and adoption of new energy technologies and very limited interest in building capacity to take part as a technology provider in the global energy market. There is no clear and comprehensive RD&D and human capital strategy for building competence in new energy technology manufacturing.

32. *IEA Turkey 2009 Review*, p. 104.

c) Nuclear Power

Turkey's interest in nuclear energy is decades old. The low variable costs of nuclear energy are perceived to be a mechanism to partially offset the volatility of fossil fuel prices. It is also assumed to enhance energy security as a non-fossil energy source. As a non-polluting energy source, nuclear power has also garnered further support on climate change considerations.

Despite all the advantages, nuclear power involves a wide range of risks and very high investment costs. The complexity of sharing the myriad risks involved in nuclear power investments between investors and the government has proved to be the main stumbling block to Turkey's nuclear energy aspirations.

The high and variable costs of construction, frequent construction delays, waste management issues during the long life of the plant, political and regulatory uncertainties that may stem from shifts in public's approach to nuclear safety, and the costly decommissioning at the end of its life are all elements of cost and risk that need to be articulated and contractually assigned before the investment can commence.

Until recently, Turkey's attempts to resolve this intricate commercial challenge had failed. The recent agreement with the Russian Federation for the Akkuyu plant appears to involve an unusual wholesale assumption of risks by the investor who has also agreed to be the operator. Based on a state-to-state agreement, this unusual model was inevitably shaped by the joint consideration of commercial concerns and political interests.

The nuclear energy project has also been advocated in Turkey as a technology transfer opportunity. However, technology transfer is not a foregone conclusion given the commercial and practical challenges in such a complex and proprietary domain. An effective and sustained effort is likely to be necessary to achieve the mutually proclaimed intent of technology transfer in the coming decades.

FINDING 8:

Turkey has recently finalized an agreement with the Russian Federation to build its first nuclear plant. The deal is based on a state-to-state agreement and has an uncommon commercial structure. The extent to which the initial political involvement will remain part of the process and complement arm's length commercial relations remains to be seen.

IV- FOSSIL FUEL MARKETS AND "MARKET STRUCTURE DISCONTINUITY"

a) Fossil Fuels

Fossil fuels will dominate the global energy supply for the foreseeable future. The shift towards other energy sources is at its core a technology policy problem; it entails significant timing uncertainty and is addressed separately in the following sections.

Affordability, secure access and sustainability are the three core concerns in thinking about fossil fuel supplies. Oil, gas and coal have distinct characteristics with respect to these three concerns. For example, coal supplies are globally dispersed whereas oil and gas[33] are geographically concentrated, so their risk profiles in terms of access are qualitatively different. Oil and coal are mostly traded in global markets, whereas significant volumes of gas are based on long-term contracts; their risk profiles with respect to pricing consequently differ. Coal has higher carbon content than energy-equivalent gas or oil, and coal power plants emit more local pollutants; their risk profiles in terms of sustainability are qualitatively distinct.

In meeting the three core objectives, should there be a national strategy guided by the state or are market dynamics better suited to find the optimal solution to this complex policy problem? If a state-guided national strategy is necessary, should it focus exclusively on national supply security or should it also set targets for the nation's energy consumption infrastructure?

If access to fossil fuels could be secured through reliable, uninterrupted, well-functioning global markets then the national energy problem would be reduced to projecting global energy prices, national demand trends and to making national investment decisions accordingly. In this simplified scenario, markets are likely

33. Although unconventional gas reserves appear to be more dispersed, the overall geographic concentration in the Middle East and Russian Federation remains.

to be better positioned to process the price signals and the need for national strategy would be limited. State involvement would be mainly through setting clear and transparent rules for private players and through remedying market failures. The state may also monitor the national energy bill as part of its economic policy-making and may seek mechanisms to hedge the aggregate bill[34]. These measures would be motivated predominantly by economic considerations to counter short-term market disruptions or fluctuations in otherwise well-functioning fossil fuel markets.

However, a reliable, uninterrupted fossil fuel supply cannot be presumed in the current state of the world. The risk of structural, long-lasting disruptions in national supply makes it a national security issue and invites deeper state involvement in energy policy. This threat is especially pronounced in fragmented markets where substitutes for existing bilateral energy relations cannot be readily secured. Pipeline based gas supply is a current example that typically generates this risk dynamic.

In response to supply risks, national energy security can pursue different strategies:

- Expanding the indigenous supply base

- Creating broader interdependence with energy exporting nations through leveraging national capacity in providing essential commodities (feedstock, minerals etc.) or the nation's geography facilitating exporting countries' access to world markets

- Diversifying the supplier base for each fossil fuel, in effect trying to approximate a global market context.

34. Such measures may entail financial mechanisms or structural hedges through investments in upstream assets in energy rich geographies. It may also be necessary to invest in the capacity for interfuel substitutability to lessen the impact of short-term price hikes in one fossil fuel market on the total national energy bill. Private actors may not sufficiently invest in redundancies or dual-fuel technologies to provide the desired interfuel substitutability in energy consumption.

The latter two strategies inevitably involve the government in actively shaping and managing the relations with supplier nations. On the other hand, expanding the indigenous supply base may in principle be undertaken by private players. However, energy resources are usually considered national assets and states maintain a certain level of control in exploration and development.

Whether the state's role in national energy strategy should extend beyond securing reliable supplies to shaping the national energy demand infrastructure is a different, but equally important question. Should the authorities actively target the share of coal, gas and oil in national energy consumption as part of national energy security?[35]

To the extent that these fuels are substitutes and their supply risk profiles are different, there will be a justified temptation to favor the fuel with the lower supply risk and thus shift the national consumption infrastructure in that direction. However, this temptation should be calibrated as shifting away from private sector determined investment decisions towards government guided consumption targets is likely to generate suboptimal economic decisions. Therefore, authorities should assess the supply risk differentials carefully and introduce demand side policy targets sparingly.

In the Turkish case, the most critical substitutability in fossil fuel consumption is between coal and gas in industry and power production. Substitutability between oil and other fuels for mobility could be just as important, but still requires massive infrastructure investments before becoming an operational alternative.[36]

As Turkey is not a natural gas producer, and natural gas markets have traditionally been fragmented, gas supplies involve a fair degree of risk. Coal on the other hand is more readily available in global markets and the country has indigenous lignite resources. Coal

35. This framework can be broadened to include renewable and nuclear energy but given that the substitution away from fossil fuels will take time, the focus is narrowed down to simplify the analysis.
36. For example, the use of CNG or use of hybrid plug-ins would build substitutability for oil in the energy system but it is still in the early stages.

supply clearly appears to be less risky than natural gas for Turkey under the current conditions. However, risk perceptions change over time. In the aftermath of the Cold War, perceived risk levels in the bilateral relations with gas producers were low and the country allowed a very rapid build-up of gas fuelled stations and a rapid rise in overall gas consumption (Figure 2). In the recent years, the perceived risk levels have been reversed and an intensifying strategic preference in favor of coal has gained traction. The most recent IEA Report on Turkey points to a rise in coal's projected share in energy consumption through increased indigenous lignite use in industry and power generation.[37]

Given that supply risk profiles fluctuate over time, the current consumption targets for coal and gas need to be evaluated based on a careful assessment of the forward-looking gas versus coal supply risk differential. The global increase in gas supplies and LNG trade and overall integration of global gas markets are likely to change the supply risk profile of gas in the coming decades. As integrated gas markets become more reliable, the risk differential between gas and coal supplies is likely to decrease and the justification for increased coal consumption may weaken. At the very least, the current projected levels may need to be recalibrated to reflect the changing risk profiles.

It is critical to be clear and transparent about the framework for decision-making regarding targets in national energy consumption. This is especially important if national strategy will override market-driven dynamics through incentives and policy interventions. It is equally important to revise such targets based on forward-looking data rather than locking-in investments based on past risk perceptions.

In thinking about whether national energy strategy should target national energy consumption patterns of fossil fuels, the other element to consider is whether future policy-driven costs may change the relative price profiles of the substitutable fossil fuels. As

37. *IEA Turkey 2009 Review*, p. 151.

policy determined costs are mainly a government-driven variable, the authorities have an informational advantage and should guide the private actors in long-term investments through improved foreseeability.

The most obvious policy-driven cost issue for the coming decades is carbon pricing. The global sustainability concerns, local pollution issues and the anticipated carbon-related discontinuities are likely to have an uneven cost impact on gas and coal costs in the coming decades. Coal generates significantly more carbon emissions than natural gas. CO_2 pricing or taxation, if globally adopted, will certainly impose a higher cost on coal than gas[38] [39]. Although, the current global public opinion may not appear resolute enough to bring about such a policy outcome, catastrophic climate events may focus minds earlier than expected. Similarly, the current global economic state is not favorable to imposing carbon emission costs, but that may change with improving economic conditions.

As power plants have long life cycles, it is important to account for the possibility of carbon emission costs in investment decisions. As carbon pricing will be the outcome of a policy action, the authorities should be very transparent about their thinking and intentions vis-à-vis carbon pricing to provide guidance to the market players. Otherwise, investment decisions will be flawed at a cost to both the investors and probably the national economy. Communicating such a key implicit assumption in the national strategy would allow a more informed national debate and would help the decision-making process of the investors.

38. An alternative strategy pursued by Germany is to heavily rely on indigenous lignite sources but to offset the carbon emission consequences through expansive investments in renewable energy. However, Turkish renewable energy technology or investment potential cannot sustain such an aggregate balancing at this stage.
39. If CCS technology is eventually deployed in both gas and coal powered plants, the emissions may converge. However, CCS investments will also be motivated and justified by relative carbon emission costs.

FINDING 9:

The relative reliance on oil, gas and coal in national energy system design is motivated by the intertemporal affordability, security and sustainability concerns.

The state's close involvement in the composition of supply among fossil fuels is predominantly predicated on the need for securing continuous supplies. The relative supply composition targeted by national energy strategy is likely to favor low-risk supplies at the expense of high-risk supplies.

To complement the targeted supply composition, the authorities are also likely to shape energy demand composition in favor of low-risk fuels where possible.

However, unrestrained state guidance in national energy consumption patterns may conflict with market determined investment preferences and may lock in economically sub-optimal investments.

RECOMMENDATION 2:

Turkey's indigenous lignite supplies generate an energy security driven policy bias in favor of coal consumption at the expense of natural gas.

Two discontinuities may impact this policy assessment and need to be addressed:

i-Expanding LNG trade and integrating global gas markets are likely to lower the supply risk profile of gas. The targeted share of coal in national fossil fuel consumption should be calibrated based on a forward-looking risk evaluation.

ii-Carbon pricing may have to be introduced due to global and national political pressures at some point in the next twenty years, which will impose a higher incremental cost on coal fuelled power generation relative to gas. The authorities should be transparent about their thinking and intentions vis-à-vis carbon emissions to prevent flawed investment lock-ins.

Having addressed the broad picture for fossil fuels, the report turns to the core discontinuity about the market structures of natural gas and oil that may shape the fossil fuel related policy decisions in the decades to come.

b) "Market Structure Discontinuity" in Oil and Gas Markets

Natural gas and oil market structures are distinct. Gas markets are fragmented and regional, mainly as a consequence of the difficulties in transporting large volumes of gas. Oil markets, on the other hand, are integrated globally. The focus of this section is to assess possible phase shifts in gas and oil market structures and to evaluate the impact of such structural changes on Turkish energy policy. Coal market structure, on the other hand, appears to be relatively stable for now.

Oil is a globally traded commodity with integrated pricing. Although the quality of oil varies across geographies and can pose refining challenges, there is effective substitutability across most oil sources. In 2011, 50,5% of global crude oil production was internationally traded and the predominant share of that trade was long distance interregional trade[40] [41]. There are globally accepted benchmark oil prices and liquid futures markets.

On the other hand, gas markets are fragmented. International trade in natural gas was 31,3% of total production in 2011. Only 10,1% of the total global gas consumption was traded as LNG and the remaining 21,2% was delivered over pipelines[42]. The pipeline trade, by its nature, is not as flexible as LNG and is effectively[43] regional trade among nations that are connected to the same physical infrastructure. Although markets like Japan and South Korea have relied on long distance LNG trade from the Middle East for some time, the overall LNG trade volume has so far been too low to sustain global integration in gas markets.

40. Eni (2012), *World Oil & Gas Review 2012;* EIA International Energy Statistics, 2011.
41. Total oil and oil products trade was 77,4% of global crude oil production.
42. *BP Statistics, 2012*.
43. Liquefaction plants may be connected to the pipeline, but pipeline trade has been predominantly among physically linked markets.

These well-established market structures may evolve in opposite directions in the coming years and decades. The unexpected increase in unconventional gas supplies and the global growth in LNG capacity have provided a strong impetus towards market integration in gas trade. IEA predicts gas use to increase by 50% until 2035 and to account for 24% of world energy demand.[44] Its share in interregional global gas trade is expected to rise from 42% in 2011 to 50% by 2035 in a fast growing global gas market.[45]

Although that would still leave pipeline trade at 50% of the total interregional trade, LNG liquidity beyond a critical threshold is likely to be sufficient to ensure global integration of the market. Once LNG trade can be employed as an easily available, economically feasible alternative, the ensuing arbitrage activity is likely to achieve global market integration. Global gas markets may be entering a phase of loosening regional interdependencies, emerging new trade axes[46] and closer global linkages.

As indicated before, such a development would lower the supply risk profile of natural gas and would make it a more attractive energy source for Turkey. Therefore, Turkey's national energy strategy should be structured to benefit from this promising change.

On the other hand, the globalized market structure of oil trade is quite robust and is likely to be preserved. Nevertheless, global security concerns and the aversion to financial volatility may force some players to seek bilateral oil investment and trade arrangements. The frequency and impact of political turmoil in oil producing countries may push some importing nations to seek more secure and geographically close oil supplies. China's increasing links with the landlocked Asian oil nations like Kazakhstan or close investment relations with players like Sudan should be monitored with caution. In the long run, diversions from global liquidity driven by an increase

44. New Policies Scenario, cited in *WEO 2012*.
45. *WEO 2012*, pp. 148-150.
46. For example, IEA's "Golden Age of Gas" scenario discusses the prospect of a strong China-Russia gas trade axis.

in the number and volume of bilateral arrangements could undermine globalized oil trade, a key pillar of the global economic order.

The implications of such phase shifts in energy market structures may be profound. The impact will range from reshaping geopolitical interdependencies and the broad energy security context, to rethinking the price-setting mechanisms and the transit security arrangements.

Such a transformation in oil markets would adversely impact Turkish national energy security and would demand a reconsideration of supply security strategies.

i. What will determine the evolution of the global oil and gas markets?

First, technical feasibility of long distance transportation is sine qua non of integrated markets. Oil is already widely transported across the globe. With the rapid growth of LNG markets, the globalized gas trade has become technically viable.

Second, national supply security impulses and risk-aversion lose force during periods of increasing global supply and low, stable prices. Therefore, new supplies of unconventional gas in the US, in China, in the broader Pacific and in Europe or the prospects of new and ample oil supplies would underpin the integration of global energy markets. On the other hand, high demand growth in Asia and tightening supplies would test energy players' reliance on the global markets.

Third, political tensions among major powers or regional conflicts that may endanger supplies would feed the risk-aversion among national policy-makers and engender increased caution. Such occurrences are likely to leave lasting impressions and favor regionalization and fragmentation in energy markets. Arab uprisings have the potential to feed such concerns.

Finally and most importantly, structural vulnerabilities of the globalized market model and how big players strategically treat these imperfections will be pivotal in the evolution of the markets. Reliance on maritime security and excess price fluctuations are significant concerns with the globalised market paradigm. To the extent that major players like China and India consider those drawbacks as major risks, they may seek non-market solutions and fragment the global market and vice versa. Integrated commodity markets rely upon maritime security, which is a major strategic vulnerability of the global energy trade. Globalized energy markets currently rely on largely US controlled maritime security, which implicitly gives the US geopolitical advantage around the globe. Such leverage may constitute an energy security risk for some nations. Chinese focus on land access to Central Asian energy resources through the recent Kazakhstan oil and Turkmenistan gas pipelines as well as the Myanmar pipeline bypassing the Malacca Strait may be considered a reflection of such security concerns.

Alternatively, if the rapidly increasing US domestic oil production leads to enduring concerns about a weakening US commitment to global maritime security, confidence in integrated global oil markets could suffer.

Beyond maritime security, excess volatility of energy prices, either due to long investment cycles or short-term financial speculation is the other structural vulnerability that may create an incentive for some nations to secure alternative supply arrangements. Long-term contracts or actual ownership of upstream resources could serve to allay strategic security concerns. Chinese investments in Africa and Latin America are moves in that direction.

In oil trade, the impact of transactions that divert supplies from the global market is likely to be limited in the short-term. If, on the other hand, such arrangements proliferate, the globalized structure of oil trade may be compromised. Even a partially fragmented oil market would pose a very different global energy order with distinct economic as well as geopolitical security concerns. In a 20-30 year perspective, Turkish energy policy would be wise to take account of this low-probability, high-impact discontinuity.

In gas trade, the shift is more likely and near. Starting from a segmented market structure the trend appears to be towards market integration. However, the security and price volatility concerns about global commodity markets may limit the full-scale adoption of global gas trade by all players. Chinese emphasis on land access to oil is already paralleled in Chinese exploration and pipeline investments in Turkmen gas.

Nevertheless, the impact of gas market integration is already afoot. As an example, the recent transforming effect of LNG trade on the EU-Russian Federation energy interdependence should be noted. EU members like the UK, Spain, France and Italy have been investing heavily in LNG re-gasification plants. The availability of alternative gas supplies to Europe is transforming the balance of bargaining power. This shift in bargaining power has already been observed in the Russian Federation's consent to renegotiating the long-term contracts and increased focus on Asian markets.

The evolution of the interdependence between the Russian Federation and the EU is a direct result of globally integrating gas markets. As this change unfolds, it may have repercussions for Turkey's transit role and access to Caspian resources.

FINDING 10:

Globalization of energy markets is a function of the technical feasibility of transport, reliability of global supply, confidence in the global maritime transport security, and manageable price volatility.

A structural shift in globalized oil markets towards non-market transactions is a low-probability, high-impact discontinuity. A shift in fragmented gas markets towards global integration is a probable, high-impact discontinuity. Both discontinuities would have a profound impact on national energy policies.

ii. Why would a phase shift in global fossil fuel market structure matter?

Before assessing the implications of market structure shifts on Turkish energy policy, it is useful to briefly set the context by addressing the global repercussions of possible market structure shifts on

i. energy security,

ii. prices and pricing, and

iii. trade and investment structures.

1. Energy security implications

Theoretically, globalized energy markets ensure secure supplies and provide a fair bargaining context for all nations. In a globalized market, a single supplier or importer has limited capacity to manipulate prices or threaten supply security. Substitutability among suppliers limits the risk of supplier or transit nations' ability to use their leverage as instruments of political or economic influence over importers. Hence the idealized version of globalized markets offers a relatively robust paradigm of energy security in international energy trade. Arm's length trade among diverse trading partners removes geopolitically distortionary bilateral dependencies.

The alternative paradigm of fragmented markets is closely entangled with geopolitical interdependencies that allow some parties, mostly the suppliers, to develop non-commercial leverage. Turkey's natural gas security concerns and the desire for diversification are a reflection of the national preoccupation with this context of bilateral dependence.

Beyond the bilateral security concerns, the interlocking dependencies of the gas trading regime generate complex political quagmires that delay commercially rational initiatives. The EU-Russian Federation gas dependence and its stultifying impact on Caspian gas exports and indirectly on Turkey's transit role is an example of that unconstructive interdependence. The Russian-European gas trade strategy has been, to a large extent, premised on European dependence on Russian supplies and thus the delay of European access to competing Caspian supplies. The Russian Federation's apparent reluctance about the Nabucco project was a manifestation of that preference. Such nationally rational, but globally inefficient strategies are frequent outcomes in the fragmented market structure context.

2. Pricing implications

Oil prices are determined in liquid global markets. Different benchmark oil prices (WTI, Brent) usually track each other closely.[47] Although speculation and stock buildup can[48] open a price wedge between these markets, they are effectively interlinked markets for different quality oil. OPEC exports are also linked to these benchmark levels. The price correlation among different markets is a useful measure to gauge the globalization of oil markets.

On the other hand there is no global price for natural gas. The US, Continental Europe and Asia-Pacific pricing schemes are different. Most transactions in East Asia and Continental Europe are long-term contracts with oil-indexation, whereas spot gas markets dominate trade in the US.

Recent developments have opened the gap between spot prices and oil-indexed levels. A shale driven gas glut has forced spot prices in the US to levels well below energy-equivalent oil prices. The LNG arbitrage link could serve as a price convergence mechanism between the US and the other regional markets. New liquefaction plants and

47. Recently, a wide spread between WTI and Brent emerged, mainly due to the logistical problems in Cushing. However, the gap has narrowed after the reversal of the pipeline between the US Midwest and the gulf Coast. Blas, J. "WTI-Brent price divergence hits record $16, February 10, 2011", available at http://www.ft.com/cms/s/0/3295504e-3550-11e0-aa6c-00144feabdc0.html#axzz1DWIkOjo1.
Farchy, J. "Crude Switch Triggers US Oil Recovery", November 17, 2011, available at http://www.ft.com/cms/s/0/07c0c7b0-113a-11e1-9d04-00144feabdc0.html#ixzz1eDMTogv0.

48. Ibid.

regulatory approvals would be required to underpin sufficient US gas exports for global arbitrage trade. Although approvals for US gas export terminals have been limited so far, the numbers are likely to increase in the coming years.[49]

Continental gas consumers, under long-term contracts with oil-indexation, have been confronted with large cost differentials and some have successfully pressured suppliers to renegotiate contract prices. Therefore, there is a very active tension between regional oil-linked gas pricing and LNG mediated global spot pricing. If the gas glut and LNG supply growth continue, a growing share of the global gas market may shift to spot or spot-indexed gas pricing.

A phase shift in the natural gas market structure towards a globally determined spot price would generate very different pricing dynamics, with significant energy cost implications for importers like Turkey.

It should be noted that the current cost advantage of spot prices over oil-indexation might be reversed in the coming years. There is a risk that delays in gas infrastructure investment due to low prices will lead to higher gas prices in the longer run. The need to consider the cost implications of the current global gas market integration is not about opting for lower spot prices. The issue is to prepare the importers' gas purchase strategy to a fundamental shift in the global gas pricing mechanism. That preparation would entail a range of elements ranging from contract design to financial risk management operations.

Shifts in market structures have a direct impact on the pricing practices of energy commodities. Given the size of Turkey's national gas bill, it is of paramount importance to be prepared for new pricing dynamics in the global gas supply.

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49. *WEO 2012*, p. 129.

3. Implications for trade and investment structures

Large global markets have a wider set of players, as well as more trading and investment arrangements. As markets become more liquid, more sophisticated trading operations are developed to unbundle and reallocate risks. Trading activities move to the core of the energy domain. Similarly, rigid ownership structures are substituted with investors who have a portfolio of partial investments in diverse assets.

The natural gas system has many components, including upstream, liquefaction, transport re-gasification and storage.

Vertically integrated operations are becoming more common. The Qatari gas supply to the UK is an example where the supplier of LNG has also invested in the South Hook terminal in Wales. Similarly, Japanese buyers of Australian gas have taken equity stakes in upstream assets like Gorgon.

Portfolio investors form another key group in the emerging global gas order. Among these investors, supermajors, international oil and gas companies, mid-stream players are investing in upstream, liquefaction, re-gasification and marketing facilities across the globe. These large global players are becoming essential actors and financiers of a large global industry.

Aggregators are important elements of the trading landscape as they match energy deliveries from their portfolio of sellers and/or buyers. They bring together customers or generators so they can buy or sell power in bulk, making a profit on the transaction.

If captive pipeline transactions and the dedicated LNG investments are increasingly balanced by flexible LNG aggregators and liquid markets, institutions and markets that aggregate demand are likely to become key players in the global gas landscape.

FINDING 11:

Globalized energy markets limit the bargaining power of single nations as consumers or producers. Such markets provide liquid global pricing mechanisms and build on thriving commercially motivated infrastructures and actors.

Fragmented energy markets lead to political interdependencies, non-market pricing and the dominance of exporting state actors.

iii. Turkish energy policy and global energy market structure

Gas markets may become more globalized with loosening regional interdependencies, increased spot pricing, and an expanding set of global commercial players. Such a phase shift may be a slow process, may happen rapidly at some point once a critical threshold of LNG supply becomes available or may never happen if demand pressures and security concerns lead importers to favor physical proximity of supplies as an energy security measure. The important point to note is that such a shift is more likely than not, and that Turkish energy policy should be designed to account for such an eventuality.

The reverse shift in oil markets is a low-probability outcome, but tight oil markets and geopolitical developments should be followed carefully for early signs of partial fragmentation. An awareness of the possibility and a broad strategic flexibility would be in order.

In addressing the policy implications, the flow of the earlier part of this section—energy security, energy costs and trade/investments—is preserved for conceptual coherence. The implications for Turkey's transit state strategy are discussed together with investment issues.

1. Energy security implications

1.1. Natural gas supply security

In fragmented markets, authorities in energy importing nations typically try to reduce the weight of any single supply source in the overall mix and to diversify sources. They may also try to create bilateral interdependencies that could serve as a lever against supply threats. Such interdependencies may include essential commodities or feedstock dependency, or may be broadened to include energy transit dependency.

Current Turkish natural gas supply security is built on the fragmented market model. The Turkish economy, especially the power sector, is heavily reliant on natural gas. Over 50% of the consumption is sourced from one supplier, the Russian Federation, and over 80% from three suppliers—the Russian Federation, Iran and Azerbaijan, all pipeline trade (Table 4)—implying a key vulnerability in national energy security.

There is no balanced interdependence with the main supplier, the Russian Federation. Turkey's energy transit role vis-à-vis the Russian Federation provides limited leverage. The transport of Russian oil through the Straits is protected under international law and Turkey is not currently a transit country for Russian gas exports.

Given this context of overreliance on a small set of suppliers, there are efforts to diversify the supply base with LNG imports from Algeria, Nigeria and Qatar.[50] The shift to reliable and liquid global LNG markets will increasingly facilitate and justify stronger reliance on LNG supplies. The agreement with Azerbaijan to access the Shah Deniz II gas field will also relieve some of the supply pressure; however, Turkey's dependence on a very small number of players will continue.

50. Recent reports about the talks between the Turkish and Qatari leadership indicated a preliminary interest by Qatar to invest in an LNG plant in Turkey.

There are also plans for new pipelines and agreements to access Iraqi, Egyptian and Turkmen gas. Given the political instability in and around Egypt and the regional political obstacles associated with Turkmenistan, Iraq presents a relatively more promising opportunity in the medium term. However, accessing Iraqi gas should be pursued as part of a more comprehensive cooperative bilateral energy effort [BOX 2]. The longer-term natural gas supply perspective should also take vast Iranian gas resources into consideration and plan facilitating Iranian exports as soon as the international political concerns and conflicts are resolved. Finally, the natural gas reserves recently found in the Eastern Mediterranean offer new options and opportunities for Turkey's access to alternative gas supplies. However, the process will require careful management of difficult legal and political complications about ownership disputes.

The Task Force believes that in the given context and in light of the shift to a more integrated gas market, national policy should articulate and pursue source diversification more systematically as a strategic goal. A quantifiable, clearly defined objective should guide the national policy in the changing context of global gas supplies. Such an objective is becoming a realistic goal as a consequence of increased LNG trade and liquid gas markets, which expand Turkey's potential gas sources beyond its neighbors. A clearly defined and pursued energy security rule would ensure accountability, transparency and long-term strategic continuity.

Until now, the room for reshaping the supply mix has been limited. Instead, managing interdependencies has been the modus operandi of gas policy with wide-ranging political implications.

An appropriately modified version of the recently adopted EU criterion for supply security may now be established as the medium term energy security measure.[51] The EU Regulation that entered into force in December 2010 stipulates that gas infrastructure should be

51. On 12 November 2010 the new Regulation (EU) No 994/2010 concerning measures to safeguard security of gas supply and repealing Council Directive 2004/67/EC was published in the Official Journal of the EU and entered into force on December 2, 2010.

flexible enough to cope with the disruption of the single largest gas infrastructure (n-1). In other words, the economy should be ready to function for a period of time when the largest supply infrastructure is cut off. Turkey should adopt a similar n-1 rule for the medium term. Furthermore, given the high risk correlation among Turkey's various supply infrastructures, the n-1 rule should be fortified to n-2* where the gas supply system will be ready to survive interruptions in two highly correlated supplies.

The n-1 rule for Turkey was tested during the Iran supply interruption of 2008 and again during the Ukraine-related West pipeline interruption in 2009. However, the system's resilience has not been tested against an interruption in the largest supply infrastructure, the Blue Stream pipeline.

Various policy elements need to be coordinated to achieve a supply security objective like the n-1/n-2* rule:

- Timely investment in new supply sources: The priority should be to invest in low-risk supply sources, which have low correlation with existing infrastructure. For example, access to Turkmen gas is highly desirable for a variety of reasons, but the use of an existing pipeline infrastructure would not alleviate energy security concerns under the n-1 rule.

  The LNG supply is much less correlated with existing infrastructure and would offer an attractive supply mechanism. To diversify the supply base under the n-1/n-2* rule, Turkey would probably need to invest in new re-gasification capacity. Whether each re-gasification facility will be counted as separate infrastructure under the n-1/n-2* rule is a policy judgment.

  It is also important to monitor the evolution of spot LNG markets to assess whether a phase shift to integrated, deep markets is indeed taking place. To the extent that such a shift occurs, LNG supplies are low-risk supply sources not correlated with existing infrastructure and should become an essential element under the n-1 or the n-2* rule.[52]

Parallel with the strategic effort to diversify supply sources, it is also important to invest in measures against short-term disruptions or fluctuations in the currently shaping integrated gas markets:

- Investment in storage: Turkey's emergency storage capacity is the lowest among OECD countries with a storage/demand ratio below 10%. This capacity needs to be expanded as an energy security measure. However, gas storage is costly and the need has to be calibrated carefully. Diverse LNG access and well-performing spot LNG markets would justify lower storage capacity and vice versa.
- Flexible consumption: As emphasized before, the economy's flexibility in fossil fuel consumption is critical for energy security. Fuel switching is an important element of flexibility. Excess capacity at coal-fuelled power plants allows a shift to coal plants when gas supplies are interrupted. Dual-fuel power plants can shift to oil when gas supplies are interrupted. Demand interruptible consumers who can shift to oil contribute to flexibility as well. Needless to say, fuel flexibility requires redundancy and is not cost-free.

To the extent that a gas supply interruption can be absorbed through reduced demand, the need for emergency supplies and storage will be curbed. Similarly, a more lenient application of the n-1/n-2* rule may calculate the demand not based on usual consumption patterns, but on minimum levels under flexible consumption patterns. Therefore, under the n-1/n-2*, storage and flexible consumption investments are components of an interlinked supply security mechanism.

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52. LNG investments, on the other hand, can be undertaken by private investors. If a strategic determination is made under a n-1 rule to expand the share of LNG supplies, it is essential to create well-functioning, liquid, liberalized natural gas markets. As an integral part of that transformation, BOTAŞ's role should be reduced strictly to transmission as stipulated in the Natural Gas Market Law of 2001.

RECOMMENDATION 3:

The shift in natural gas markets away from fragmentation to integration will allow an energy security context less defined by political interdependencies and more driven by market dynamics.

i-If the LNG markets increasingly provide a reliable, diverse supply base, national gas supply security strategy should be guided by a clear, quantifiable rule. The medium-term objective for Turkey should be to achieve the n-1 infrastructure standard if supply source risks are sufficiently uncorrelated and the stricter n-2* standard if they are correlated.

To the extent that LNG market reliability reduces the overall supply portfolio risk for Turkey, storage and utilization redundancy investments can be reduced.

ii-If the natural gas markets remain fragmented, Turkey's dependence on a very small number of suppliers can be an energy security risk with highly entangled interdependencies. There is a need for creating more balanced interdependencies. Storage and demand flexibility investments are of paramount importance.

1.2. Oil supply security

Oil is traded in a globalized market and therefore Turkey can secure supplies from a wide range of sources. The nature of the current energy security problem for oil fundamentally differs from natural gas.

In the globalized oil market context, the broad energy security challenge is the possibility of a breakdown in global oil trade or a financially unsustainable price hike.

The dominant use of oil in Turkey is in transportation, at 51% of annual oil consumption.[53] At present Turkey's mobility is highly dependent on oil with very low price elasticity.

53. Based on statistics taken from the website of Republic of Turkey Ministry of Energy and National Resources, 2011 Energy Balances, available at www.energy.gov.tr.

The oil supply security also has a more strict national security dimension. Oil is the dominant fuel for the essential mobility needs of the nation, including the demands of the armed forces. This need would be particularly relevant during times of armed conflict. The military's ability to safeguard maritime access for oil supplies and refining capacity, as well as the availability of strategic storage facilities, would be essential elements of the policy preparation for this contingency.

In the current state of global oil markets, national strategy is more concerned about price fluctuations and short-term disruptions in global supplies. Storage for emergency supplies, acquiring upstream assets for hedging, and investing in financial hedging are possible measures against market fluctuations. High price elasticity of demand would help absorb the fluctuations to some extent, but unfortunately the current elasticity levels are very low. Flexibility of demand would entail reducing the vehicle fleet's exclusive reliance on oil and introducing modes of public transport that run on other energy sources. Again, the flexibility benefits should be evaluated in relation to the costs of implementation.

If the price volatility increases and/or supply breakdowns become frequent, there may be a partial fragmentation of the market, in which case Turkey would need more structural mechanisms to survive in the new context. Balanced interdependencies with oil suppliers and upstream stakes in neighboring oil-producing nations are elements of such structural solutions.

With respect to interdependence, Turkey's existing transit nation status in oil is a critical asset in case of a breakdown or long-term fragmentation of the global oil supply system. Turkish authorities can negotiate secure supplies in return for the transit role from the suppliers in such a contingency or structural shift. The oil transit status provides a pivotal interdependence with some suppliers that could serve as an important oil security default mechanism. Since Turkey serves as an oil transit country for Azerbaijan, Iraq, the Russian Federation and Kazakhstan, achieving balanced interdependence with a subset of these suppliers may be sufficient to ensure oil supply security. Upstream investments in these nations can further enhance the interdependence. Among these nations, the immense potential of Iraq presents an immediate opportunity. Geographic proximity, the existing pipeline link and increasing trade flows make Iraq a natural energy partner in the region [BOX 2].

The most effective structural response to fragmented, high security risk oil markets would be to reduce dependence on oil. Increased uses of bio-fuels, dual-fuel vehicles, and, in the long run, electric cars are all elements of a structural shift in demand dynamics that would fundamentally strengthen Turkey's resilience against a high-risk oil supply context.

RECOMMENDATION 4:

i-Globalized market context:

Oil supply security in a well-functioning globalized market context requires storage and demand flexibility, especially in transportation. Credible and transparent targets in storage and demand flexibility should be established to guide policy.

Oil supply security also has a more strict national security dimension in ensuring the mobility of armed forces. Policy design should treat this dimension separately, but embed it in the broader energy security framework. Strategic storage capacity and ensuring a minimum supply at all times are elements of this core security problem.

ii-Structurally unreliable oil markets and fragmentation context:

If breakdowns or crises become frequent in the global oil supply system, price volatility increases or key players seek off-market oil supplies, Turkey would be well-advised to reconsider its oil supply strategy posture. The reconsideration would require a focus on bilateral interdependencies with supplier nations, preferably enhanced with upstream oil investments.

Although such a shift is not an immediate concern, Turkish oil security policy should devise and develop such default strategic interdependencies as part of its long-term strategy to encounter possible adverse shifts in global oil market dynamics.

BOX 2: IRAQ AS AN ENERGY PARTNER:

Iraq is a nation with vast hydrocarbon resources. Its oil and gas reserves are rapidly being developed and there are ample opportunities for further exploration and development.

Turkey is a natural energy partner for Iraq. As a neighboring nation with increasing oil and gas demand, Turkey is an obvious market for Iraqi hydrocarbons. Furthermore, Turkey offers one of the most reliable and convenient routes for Iraqi hydrocarbon exports. The Kirkuk-Ceyhan oil pipeline has been in operation since 1976 and was extended in 1987. It is Iraq's largest crude oil export line.

Furthermore, the trade between the two countries is expanding rapidly and has reached $10,8bn[54] in 2011. Turkish contractors are active in Iraq with a business volume of $1,9bn[55] in 2011 including various infrastructure projects.

Going forward, there is significant potential for cooperation in energy projects:

-Turkey can contribute to increased hydrocarbon production in Iraq by taking part in the development of oil and gas fields. The Turkish Petroleum Corporation was awarded the tender to develop Mansuriya and Siba gas fields, the former as an operator and the latter as a consortium partner.

-The Kirkuk-Ceyhan pipeline agreement was extended in September 2010. As Iraq's oil and gas production increases, there will be scope for additional pipelines to Turkey.

-Iraq has significant power generation shortfall and will invest in rehabilitating and expanding its electricity network. Turkish companies are active players in this sector and have been awarded three contracts in 2011.

-Until Iraq installs capacity to achieve self-sufficiency in power

54. Based on statistics taken from the Republic of Turkey Ministry of Economy's website, available at www.economy.gov.tr.
55. Turkish Contractors Association's website, available at www.tmb.org.tr.

generation, it will remain a power importer. Turkey can export electricity if the interconnection infrastructure is expanded.

A comprehensive energy partnership between Iraq and Turkey can contribute to Turkey's energy policies at different levels:

-Energy security through interdependence: Extended pipelines, electricity trade, food and other essential exports could create a structure of mutual interdependence, which would contribute to national energy security.

-Upstream investments: In a context of broadening energy cooperation, Turkey can invest in Iraq's oil and gas fields. Expanding its upstream assets would allow Turkey to strengthen its role as a regional energy actor and to partially hedge itself against price hikes.

-Strategic step towards being an energy trading hub: If Turkey intends to play a central role in oil and gas trade, teaming up with hydrocarbon rich neighbor(s) will help the process. Securing a critical threshold of supplies is critical in jumpstarting such a process. Both Iraq and Turkey are likely to benefit from the emergence of such a trading hub.

2. Pricing implications

The cost of national gas supplies is predominantly determined by oil-indexed pricing under long-term supply contracts whereas oil costs are predominantly determined by current market equilibrium.

2.1. Natural gas

The structural shift in gas markets towards integrated, liquid spot markets is likely to offer a viable market-driven pricing alternative. Gas pricing under long-term contracts may shift from oil-indexation to spot gas indexation, or at least a combined formulation. Alternatively, increasing volumes of gas may be traded without long-term contracts in the spot markets.

This presents a very significant policy challenge both intellectually and practically. Should Turkey prefer to link a part of its national energy bill to spot gas markets? If it does, can Turkey convince its existing suppliers to modify existing contracts or should it simply shift new supplies to spot pricing?

Spot prices will probably fluctuate in the coming years and decades and may be lower or higher than oil-indexed pricing. As a consequence of the gas glut, the recent experience has been a decrease in gas prices to very low levels compared to oil. Although the US price has been exceptionally low, the attractive spot gas prices have also been available to European importers. However, there is a distinct possibility that low gas prices will induce more consumption and curb new gas investments in the medium-term, which could lead to an eventual increase in spot gas prices.

Therefore, the policy choice between oil-indexed and spot gas linked pricing is not straightforward. The basic change is that spot market linked pricing has become a viable alternative and the policy-makers have to take that into account in their gas purchase planning.

The gas glut driven by expanding shale gas supplies and excess LNG/pipeline capacity is likely to restrain gas prices unless rapidly growing Chinese and Indian demand absorbs the supplies much sooner than expected.

In the medium to long term, the decreasing unit costs of renewable energy are likely to increase the price sensitivity of gas in power generation and serve as a structural brake on gas prices. Therefore, there are structural reasons to believe that spot gas pricing in national supplies may contribute favorably to national energy bills. The possibility should be explored further.

The practical dimension of shifting to spot gas linked pricing is a separate matter. In the short-term, mainly LNG purchases are amenable to spot pricing but Turkey's LNG processing capability is limited. In the medium to long run, new re-gasification plants would broaden the potential for such a change in pricing practices. Similarly, Turkey may renegotiate existing pipeline contracts or negotiate new contracts that would link its pipeline purchase prices, in some ratio, to spot levels.

As a consequence of the gas glut, long-term suppliers have agreed to modify the oil-indexed pricing formulas with some clients for limited periods. Gazprom and E.ON Ruhrgas agreed on linking 15% of the volume to spot prices for a three-year period. Gas Terra is incorporating decoupling from oil-indexation in new contracts.[56] Market forces are already convincing the suppliers to offer gas indexation as an option. The phase shift in gas markets structure is already having an effect on the dynamics of gas pricing. If the Turkish authorities decide to include spot gas linked pricing in Turkey's gas bill, a determined policy initiative should be undertaken to renegotiate existing contracts and/or systematically shift to spot pricing in new supplies.

The decision to introduce partial spot pricing and its precise formulation is a technical matter. However, there is sufficient reason to think that it is a desirable and feasible option. The option will become increasingly viable if the gas markets become increasingly

56. IEA (2010), *Medium-Term Oil and Gas Markets 2010*, OECD/IEA, Paris, p. 200.

more integrated, liquid and reliable. Turkish energy policy planning should be prepared for the transformation.

2.2. Oil

The oil price is determined in global markets and the Turkish authorities, along with other national decision-makers, struggle with price fluctuations.

Beyond this traditional policy challenge with respect to prices, the contingency that needs to be considered for strategic planning is a lasting structural increase in oil prices.

On the demand side, mechanisms of inter-fuel substitutability should be a key element of the policy design. Flexible-fuel vehicles, bi-fuel vehicles that can run on CNG, and electric vehicles all constitute infrastructure transformations that can increase fuel-substitutability.

On the supply side, the focus has to be on hedging mechanisms against lasting price spikes. As an oil-importing nation, the most reasonable, albeit difficult, mechanism for Turkey is to plan and invest in natural hedges against such contingencies.

Stakes in upstream oil assets could serve as a natural hedge and would be particularly robust mechanisms if the asset were in a country that has a transit dependency on Turkey. Investments in new Iraqi oil fields present an important opportunity in this respect.

Alternatively, the bilateral interdependencies discussed above could be designed to involve a pricing linkage. If the mutual interdependence with the oil-producing nation is based on Turkey's energy transit role, or on sales of essential commodities, the transit fee or the commodity pricing can be linked to oil prices under pre-specified conditions.

RECOMMENDATION 5:

Pricing of natural gas and oil are closely related to market structures:

i-The increasing integration of gas markets is paving the way for more liquid, reliable spot gas pricing alongside the traditional oil-linked pricing. Turkish policy-making should take this shift into consideration in planning and shaping its gas purchase strategy.

The current gas glut and the decreasing trajectory of the unit cost of renewable sources in the long run favor at least a partial shift to spot gas linked pricing. The shift can be achieved by renegotiating existing contracts or by opting for spot linked pricing in new purchase agreements.

ii-Structural shifts may force a lasting increase in oil prices.

The Turkish oil supply strategy should be to monitor such developments closely and be ready to deploy natural hedging mechanisms against the economic impact of such low-probability, high-impact contingencies. Upstream stakes in oil assets and oil-price linked commodity interdependencies with oil-exporting states should be considered as possible alternatives.

3. Implications for energy investments and "transit country" strategy

The Turkish strategy of becoming a key transit country has mainly focused on the energy corridor function while paying lip service to the objective of serving a more central role in energy trading. Although the strict corridor function financially provides a stable stream of income, it does not entail the possibility of Turkey emerging as an active, leading player in energy trade.

Politically, the corridor function leads to dependence of the exporting and the importing nations on Turkey's provision of safe pipeline access. However, a responsible international player cannot use such leverage without incurring enormous political costs once the pipeline is in place. It may only contribute to energy security during exceptional circumstances like the breakdown of the energy supply system due to conflict or other security crises. Furthermore, the corridor function has not so far provided Turkey with sufficient leverage to become an effective upstream partner in the neighboring nations that rely on Turkey for market access.[57]

Admittedly, the corridor role is a relatively easier strategy to implement than a central trading role. It may even be argued that the corridor role is a prerequisite to a more active trading function. However, shifts in the global gas market structure are likely to have a significant impact on the dynamics of the industry as well as energy politics.

The current shift from the dominance of suppliers to buyers in natural gas markets may prove to be the early stage of a structural transition. The gas glut and the growth of LNG trade have provided larger supply volume and diversity to buyers. To the extent that the current balance favoring buyers continues, the ability to access and coordinate demand is likely to become a key element of international gas markets. Attracting the private players who coordinate demand in global trade may be as important as convincing the national suppliers.

57. TPAO's 9% share in Shah Deniz is an exception.

If this phase shift indicates a permanent change, there may be an opportunity for Turkey to assume a more central trading role and to link the neighboring supplies with the growing LNG demand as well as the more traditional pipeline-based demand. Although the emergence of such a possibility does not necessarily imply the commercial desirability of such a strategy for Turkey, it offers a new strategic option that deserves close scrutiny.

A trading role in this newly emerging context would have to coordinate private commercial interests with national suppliers synchronously. On the private side, generating interest among traders, aggregators, and portfolio investors to become stakeholders in a Turkish gas trading hub is not likely to be easy, but the probability of success is likely to increase as vibrant LNG markets develop and gas markets evolve.

On the supply side, the neighboring gas rich national actors may gradually find it in their interest to access an active trading node with the requisite facilities, including LNG liquefaction infrastructure. As in any market place, increasing return dynamics would be likely. If a modest trading center were to emerge, it could attract gradually new demand and regional supplies. Given the political deadlocks in the neighboring suppliers, a thriving commercial hub could expedite their decision-making. Over time, even the game changing entry of Iran into the global gas market may be facilitated and accelerated by an available trading hub in Turkey.

The emergence of a successful energy trading zone could also provide Turkey with the so far missing leverage to become a stakeholder in upstream assets of prospective suppliers. If portfolio investors become stakeholders in a possible trading zone, organizing joint financing and creating vertically integrated structures may become feasible.

The planning, coordination and final implementation of a natural gas trading hub initiative is an immensely complicated effort. The usual requirements about rule of law, predictable regulatory regimes, and low transaction costs are sine qua non of such an initiative. However, the scalability, the national leverage and the implicit options it encompasses may offer a high payoff financially and politically.

Commercial viability of a more central role for Turkey in gas trade is not a foregone conclusion but it deserves a careful strategic assessment. A comprehensive feasibility assessment and roadmap should be prepared.

The change in the global natural gas market impacts all aspects of the global energy order. Old constraints may evolve, weaken or even disappear. Turkey's transit country strategy and upstream investment policies should be reconsidered and, if appropriate, revised. The opportunities in the current shift may be profound for Turkey's energy role in the coming decades.

RECOMMENDATION 6:

Turkey's potential transit role in gas has predominantly focused on the energy corridor formulation while paying lip service to a more central trading role.

The current evolution of the natural gas markets presents a new environment for Turkey to consider a more central trading role in the region.

The growth of LNG trade is likely to shift the balance in favor of commercial interests over strategic considerations in global gas trade. Forging a central trading role in this context would require not only access to reliable supply sources, but also an informed management and fulfillment of commercial expectations.

A thriving trading zone in the region could gradually align national interests in the area by providing shared access to global markets driven by commercial interests rather than rivalries shaped by rigid interdependencies.

An economic and political feasibility assessment of Turkey's potential natural gas trading role should be undertaken, duly taking into account long term risks as well as the promising options involved.

iv. Institutional recommendations for fossil fuel strategies

National oil and gas supply security requires a macro strategy as well as the national competence to execute such a strategy. Governments usually assume the leading role in charting the long-term national strategy. However, execution of strategy almost inevitably requires some level of private sector involvement. The private sector can provide financing, technology, expertise in managing complex projects and networks of influence to facilitate or even propel the national energy strategy forward. The absence of national execution capability in exploration, development, refining, gas liquefaction or re-gasification can be a limiting factor in achieving national objectives.

As indicated in the preceding discussion, oil and gas markets may be fragmented or integrated. In fragmented markets, creating interdependence with suppliers provides a certain level of insurance against disruptions. Involvement in upstream assets or energy infrastructure in oil and gas exporting countries enables balanced energy cooperation and interdependence with those nations. Turkey is surrounded by fossil fuel rich countries, and investment opportunities for such balanced interdependence will arise as the region evolves [BOX 2]. Pursuing such opportunities demands political leadership as well as execution capacity.

The Turkish Petroleum Corporation, a state-owned company, has already accumulated expertise in execution and is a player in the region. However, given the significance and magnitude of the strategic purpose, Turkey would benefit from broadening and strengthening its technical, financial and executive capacity in the energy domain.

In globally integrated markets, the role of the private sector becomes even more pronounced. If Turkey intends to assume a more central regional transit and trading role in natural gas and/or oil, its private sector would need to assume a leading role in that process. Such an ambitious undertaking would demand large infrastructure investments like pipelines, refineries, liquefaction and re-gasification plants and sizeable storage facilities. It would require a well-functioning, liquid, and reliable trading environment with supporting financial markets. Large international energy players would need to be drawn to the emerging hub. Commercial arrangements will need to be negotiated to encourage neighboring suppliers to become stakeholders in the whole project. Positioning Turkey as a key energy player would certainly require state leadership but it is an intensely complex commercial process where extensive national business engagement will be essential.

Therefore, Turkey's national energy strategy involving fossil fuels requires very close coordination between the government and the private sector. In the absence of effective institutional mechanisms to underpin such coordination, it may become very difficult to execute even the best-crafted energy strategies.

Given the competitive nature of private enterprise, there is bound to be challenges and risks in designing an institutional mechanism to coordinate private actors. It is important to ensure that the coordination and cooperation remains at the macro level strategy where inter-firm rivalries can be sidetracked. Similarly, close engagement between the government and the private sector carries its own risks and should be transparent to the extent that it is realistically possible. Independent accountability mechanisms should be instituted to monitor processes that may be considered confidential in nature.

Designing and implementing a generic institutional structure for coordination may be difficult at the outset and may face skepticism. Instead it may be more appropriate to initiate the process around well-defined problems. In light of the discussions in this report, Turkey's energy strategy vis-à-vis Iraq and Turkey's potential role in natural gas trade in a changing global gas environment are two areas of significant national interest. Bringing together private players and related public authorities to discuss and propose national roadmaps in these two areas would provide the initial focus and motivation for long-term coordination. However, given the vast potential in the broader region, the initial focus on Iraq should be complemented with a longer-term regional strategy from the outset.

The long-term goal should be to build institutional structures to ensure effective public-private cooperation in implementing national energy strategies.

RECOMMENDATION 7 - INSTITUTIONAL:

The report identifies the need for executive capacity in pursuing national oil and natural gas supply strategies. Establishing the mechanisms of mutually reinforcing national strategy and executive capacity requires close coordination between the public and the private sectors.

Institutionalizing such coordination through generic structures at the outset may face institutional difficulties and skepticism. Instead, the Task Force recommends two ad-hoc committees to chart the roadmaps in two key areas of Turkish energy strategy. The committees will comprise leading private players as well as related public authorities:

i) The Committee on Energy Cooperation with Iraq and the Region

ii) The Committee on Turkey's Role in Natural Gas Trade

These committees should be conceived and shaped with the goal of establishing institutional mechanisms for closer coordination and cooperation between the public and the private sectors to serve Turkey's long term national energy strategies.

V- NEW ENERGY TECHNOLOGIES (NET) AND "TIMING UNCERTAINTY"

Global warming concerns constitute a powerful argument in favor of efficiency and clean energy. Similarly, energy security favors energy efficiency and, most of the time, clean energy. Energy efficiency and clean energy both rely on the development, improvement and implementation of new technologies. Technology policy discussions increasingly complement the traditional geopolitics of fossil fuels in shaping energy discussions. Energy policy has become a technology policy challenge as much as a political or economic consideration.

Although the trend towards clean and efficient energy is unidirectional and unmistakable, the scope and pace of the transformation are uncertain. The change depends on a variety of factors, including fossil fuel prices, public acceptance of nuclear energy, visible and damaging signs of climate change, fossil fuel driven conflicts and crises, technological improvements and cost reductions, the public's values and preferences, together with national and international politics. The pace of change is likely to be erratic, spurred and strained by crises, popular demand, political gain, as well as lethargy.

It is very difficult to predict which technology will speed up at what point and how fast. Not having such foresight, the simple and straightforward policy advice is to pursue a portfolio of technologies at the global level. However, the portfolio approach should not mask the nature of the problem, which is essentially to manage and exploit a large set of unforeseen discontinuities in the energy technology domain.

For example, seemingly simple disruptive technologies like Light Emitting Diodes (LED) can have a significant impact on global energy use. Cost reductions and technology improvements of LEDs could transform the lighting sector. The National Academy of Sciences (NAS) reports potential global savings in the order of

10% of global electricity consumption.[58] When and at what pace that transformation takes place can have a substantial impact on the global energy picture. The expected impact on the energy domain is significant, but the pace of progress is unknown.

Clearly there are formidable challenges to all new technologies and many of these technologies may not succeed or even survive. The point is not to put our hopes on pleasant surprises, but to emphasize that there is a range of technological possibilities, which could have a disruptive and significant impact on the energy equation if and when they become technically and economically feasible. Abrupt and disruptive changes are an essential part of technology development and energy policy designs should be prepared for that. In the face of such uncertainty, policy design should invest in options that would allow the exploitation of opportunities when they arise and avoid lock-ins that would prevent viable low-cost transformations in the energy domain.

The technology aspect of national energy policy entails two distinct challenges:

- when and how to deploy NET in the national economy (technology absorption)
- whether and how to become a global supplier of NET (technology generation)

The "technology absorption" problem is at its core an energy policy problem. The objective is to diversify energy sources, improve energy security, and reduce energy cost level and volatility by employing new efficiency and generation technologies. Timing is a critical issue as new energy technologies are continuously improving and moving down the cost curve. The challenge is to set the technology absorption timing to secure the optimal cost profile for the economy and to avoid costly lock-ins while not being perceived as an irresponsible global climate free-rider.

58. The National Academy of Sciences website, Energy Efficiency: Lighting, available at http://needtoknow.nas.edu/energy/energy-efficiency/lighting.php.

The "technology generation" challenge is essentially an industrial or technology policy question. The policy-makers need to strategically assess various segments of energy technologies and decide whether the national knowledge and production assets are strong enough to sustain a national strategy of becoming a player in such technologies. As the industrial policy horizon expands into the future, the inherent uncertainty about timing and scope of new technologies will require an increased focus on flexibilities and optionalities in the national technology generation capacity.

"Technology generation" and "technology absorption" are related but distinct objectives. It is important to be clear about objectives in designing policies. Investing in national capacity to generate new energy technologies requires a whole set of policies and institutional mechanisms that are very different from the respective measures for technology absorption. Advocates of either objective may derive political leverage in support of their cause from blurring the distinction. Policy-makers need to be clear about objectives and ensure that their policies are each tailored primarily to their stated purpose.

While demarcating the two main policy objectives is critical for focused policy design, it is also important to be aware of the mutual interaction between these two objectives and leverage them with appropriate mechanisms when necessary:

i. Technology absorption policies may create local demand for technology generation:

   Creating national demand for new energy technologies may spur the emergence of national industry/technology competence in certain energy segments. However, without a comprehensive industrial policy supporting the supply capacity in those segments, simply providing a domestic market is unlikely to be successful.

ii. Industrial/technology policy can inform technology absorption policy design:

Industrial/ technology policy in new energy technologies should be by its nature forward-looking and inform the national debate about projected future developments in new technologies. Detailed policy awareness of up and coming technologies will allow better-designed technology absorption policies that can build in flexible infrastructures and avoid lock-ins accordingly.

iii. Human capital and tacit knowledge:

Tacit knowledge acquired in either technology generation or technology absorption can be a useful input in either track. Human capital is particularly important in this respect.

Demarcating the objectives of energy technology policies while being aware of mutually reinforcing dynamics of technology generation and technology absorption will allow for better designed and more focused policy initiatives. Intellectual discipline may be difficult to maintain, but will prove to be an important asset for policy efficiency and impact.

RECOMMENDATION 8:

Energy strategy and planning increasingly relies on energy technology policy as much as on political or economic considerations.

The "capacity for generating new energy technologies" and the "capacity to absorb existing technologies" are two distinct components of the energy technology policy.

Turkish energy technology policy debate and institutions should be structured to clearly demarcate these two objectives. Intellectual and institutional discipline in maintaining clarity of objectives is critical for energy technology policy efficiency and impact.

Optionalities and lock-ins in technology absorption policies are essentially society-wide considerations involving long time-horizons, scale economies, externalities, and costly investments in flexible structures. Private players are unlikely to have the requisite time-horizon, the risk appetite or the financial wherewithal to invest in such optionalities. Public authorities have a key role to play in addressing those uncertainties.

NET generation policies similarly demand government support, or at least guidance. NET present a potentially vast and diverse area of global economic activity. Given the large upfront investments, significant uncertainties and market imperfections, public sector engagement is critical. As the main actors in the commercialization of NET will still be the private corporations, public policy formulation, coordination and implementation mechanisms should rely on the practical complementarities of public and private sectors.

RECOMMENDATION 9:

NET generation and adoption entail uncertainty, long-time horizons, externalities, scale economies and even political resistance by the incumbent energy industries.

In the absence of the public sector's involvement, guidance and policy support, most of these structural obstacles cannot be overcome. The government has to take a role in advancing NET.

Turkish energy policy design should have a coherent, well-defined, transparent, professionally executed role for the public sector in energy technologies.

The next section summarizes some broad measures about the targeted and actual investments in new energy technologies around the world. This summary provides a context for Turkey's energy technology policies.

Then the "technology absorption" policy framework is addressed followed by "technology generation" policy issues. Institutional analysis and suggestions conclude the section.

a) Context for Turkish NET Policy: How Fast is the World Investing in NET?

The IEA reports that under the current policies, energy-related CO_2 emissions will double by 2050. That implies a long-term global temperature increase over 6°C with catastrophic consequences for human civilization. The alternative optimistic scenario of approximately halving energy-related CO_2 emissions by 2050 is expected to keep the global warming below 2°C with 80% probability.[59] The latter scenario requires a broad strategy for developing and investing in NET around the world. Every year that the world delays its shift to the necessary new technologies, the shift becomes more costly and may soon become unattainable.

The 2°C scenario demands an additional 36tn USD investment relative to current policies in low-carbon energy technologies until 2050.[60] Such an investment would imply significant growth in NET.

The ambitious targets of the optimistic scenario present an important long-term global benchmark for Turkey's long-term carbon and energy intensity policies, and the pace of absorbing NET. Although Turkey's current performance is not alarming, inaction could over time run the risk of divergence if the world moves towards high efficiency, low emission targets.

59. IEA (2012), *Energy Technology Perspectives 2012*, OECD/IEA, Paris (hereinafter referred to as *ETP 2012*), pp. 30-33.
60. *ETP 2012*, p. 135.

However, it is important to look beyond required investments and gauge the actual global intent to move towards the environmentally responsible scenario. RD&D expenditures and actual current NET investments provide a measure of the intent at which new energy technologies are likely to grow.

IEA reports that energy RD&D in IEA countries was at 0,03% of GDP in 2008. The global public RD&D in energy was approximately 10bn USD in 2009. However, to achieve the environmentally responsible outcome by 2050, the estimated global annual RD&D expenditure required was projected by IEA to be around 40-90bn USD. Anticipating that half of the total RD&D spending will be assumed by the private sector, IEA estimates a current RD&D public budget gap of 10-35bn USD annually around the globe[61]. Despite pervasive political statements about the threat of global warming, the share of RD&D spending for energy in total OECD public RD&D budgets has varied between 3% and 4% since 2000.[62]

The actual current global investments in low carbon technologies paint a similar picture. IEA reports that the 260bn USD investment in renewable energy will have to reach an annual level of 1tn USD in 2030[63] to achieve the low-carbon scenario.

The investment gap is equally striking in non-OECD countries. For the 2°C scenario, the additional low-carbon technology investments required in non-OECD countries is 226bn USD annually from 2010 to 2020 and 439bn USD annually from 2020 to 2030.[64]

These measures have two important implications for Turkish energy policy discussions. First, the global NET sector is not yet growing nearly as rapidly as projected and desired but is likely to shift to a much steeper trajectory when the global consciousness about the awaiting climate crisis leads to responsible action. Turkey still has

61. *ETP 2010,* p. 480.
62. *ETP 2012,* p. 111.
63. *ETP 2012,* p. 149.
64. *ETP 2012,* p. 152.

time to position itself before the NET industry starts its promised and long anticipated growth trajectory. The seemingly inevitable NET growth story is likely to offer opportunities to nations with well-positioned manufacturing and knowledge sectors.

The second implication relates to the timing and pacing of Turkey's NET absorption. Unfortunately, the global RD&D performance and new technology investment outlooks do not indicate a determined global strategy to lower carbon emissions in the near future. Within this context, Turkish carbon emission reduction strategy and clean energy investments should be paced accordingly.

FINDING 12:

Global funding for energy RD&D and investment in NET is still only a fraction of the projected levels to achieve carbon emission reductions that may limit global warming to 2°C. Global proclamations about carbon emissions targets are far from being supported with adequate global investments.

RECOMMENDATION 10:

Although the surge in NET investments is currently much below desired levels, the impending climate crisis suggests an inevitable and steep NET growth trajectory with uncertain timing. Turkey still has time to position itself to benefit from this potential growth industry before it commences its steep ascent provided that it can execute a determined strategy to build up its NET manufacturing and knowledge sectors.

b) Policies for NET Absorption

As noted before, NET can be formulated both as a domain of industrial policy and as a response to the energy policy challenges. Industrial policy and energy policy rationales are very frequently intertwined and, consequently, conceptual entanglement clouds the policy discussions. In this section, the main focus is on energy policy rationales motivated by supply security and climate change concerns. Mutually reinforcing interactions with NET related industrial policies are addressed where appropriate.

A second source of confusion is the distinction between energy security and carbon efficiency. Although the two objectives frequently overlap, they may diverge at times and policy discourse and design should be clear about the distinction. This requires particular attention in assessing some clean fossil fuel technologies and the use of bio-fuels; it may also become important in evaluating electric vehicles in countries where fossil fuels dominate power generation systems. In these cases, carbon efficiency does not necessarily imply improved supply security.

Once the key ambiguities around NET discussions are clarified, the next stage of the policy process requires a framework to incorporate various costs and benefits. The context of the problem is dynamic and thus demands an inter-temporal framework that can address requisite flexibilities.

The policy problem is simpler for technologies that are already competitive with existing alternatives. For those technologies, the markets would and should determine the pace of adoption. Policy should simply aim to remove obstacles to the market mechanisms.

The more difficult policy challenge is for NET segments that are not yet price competitive and require a policy push to be adopted. Policy-makers should initiate, calibrate and pace the policy push necessary for the absorption of NET segments that are not yet cost competitive by weighing the gravity and urgency of the security, cost and emission concerns.

In theory, core energy policy objectives favor absorbing most NET segments in terms of both supply security and reductions in emissions. On the other hand, cost considerations still do not justify a mass deployment of many NET segments. Finding the right timing and determining the pace of policy support demands a clear assessment of intertemporal considerations:

i. Which segments of the still uncompetitive NET options can realistically make a qualitative contribution to Turkey's energy security and carbon emission reductions today if a reasonable policy impetus is provided?

ii. What are the costs and benefits of delaying policies that support each NET segment? At what point in the future can NET segments make a qualitative contribution to energy security and carbon emission policies? What is the right time to provide a policy impetus?

iii. How can Turkey be ready to deploy favored NET segments en masse if security, cost and climate considerations justify a widespread adoption of certain NET segments at some point in the future?

Can Turkey make a significant contribution to its energy security/ carbon emission problems today by investing in NET at reasonable cost?

There is no doubt that supply security and emission targets should be at the core of energy policy and that most NET segments can serve both objectives. However, at this point in time, the absorption of any NET segment is unlikely to make a qualitative change in Turkey's energy security or carbon emissions even with a reasonable national policy push. These limited security or climate benefits of NET today need to be balanced against the costs of a policy that will support each segment. The current balance does not indicate a clear justification for a massive deployment of NET.

Do future benefits and costs of deploying NET justify policy support today? If not today when?

Decreasing costs of NET favor delaying NET investments

The core uncertainty in cost calculations is the rapidly changing cost profile of NET segments. NET cover a wide range of technologies including renewables, clean fossil fuels used in power generation (mainly CCS), and efficiency technologies in transportation, buildings, industry and power plants. These technologies are varied and are all in the process of maturation with decreasing unit costs. Given the downward sloping cost curves, locking in NET investments shortly before major technology and cost improvements is an inherent timing risk in NET policy design.

…but delaying NET will lead to expanding fossil fuel infrastructure lock-ins

On the other hand, delaying new technologies in anticipation of lower costs in the future, leads to continuing investments in fossil fuel powered plants, buildings, cars with long life-cycles. Avoiding the decreasing cost problem of NET comes at the expense of locking in the expanding fossil fuel based infrastructure.

…and NET investments today may embed positive externalities for the future

NET may incorporate implicit options that may be of value for the national economy in the future. Investing in NET generates trained human capital and tacit knowledge in these technologies, which would be necessary if the adoption of such technologies gains pace at some point in the future.

Similarly, if the nation has a well-crafted industrial policy targeting NET, the competence gained in NET absorption could be of value.

However, it is worth re-emphasizing that these implicit options should be assessed carefully as they are unlikely to be of value in the absence of a comprehensive policy context that could leverage the developed competences. Policy design should be very strict about the broader industrial, technological or human capital policy requirements that can exploit these implicit options. Wishful thinking in the absence of supporting mechanisms is more than likely to generate wasteful activity. Provided that such a policy context exists, then the implicit options embedded in NET investments may justify stronger policy support for NET that are still at a cost disadvantage to existing alternatives.

How can Turkey be ready for mass deployment of NET segments when the intertemporal considerations justify a determined policy push?

Even when certain NET segments are able to make a significant contribution to energy supply or use, it will not be possible to deploy many of them in the absence of requisite infrastructure investments. Key infrastructure investments like smart grids or fuelling station networks are critical barriers to mass deployment of new technologies. Therefore, timing and planning of key infrastructure investments should be an integral part of the overall policy planning effort.

In summary, the policy makers have to time, calibrate and pace national energy technology adoption policies and investments by balancing security and climate objectives with the timing uncertainties of cost curves. This calculation should also account for lock-in costs of expanding fossil fuel infrastructure. Embedded options in NET investments should also be taken into consideration in support of NET investments, but only if the broader policy context is in place. As part of a forward-looking strategy, it is critical to plan ahead for infrastructure investments that will allow for a rapid spread of new technologies when their adoption is justified. Creating infrastructure optionalities should be a key element of the intertemporal policy planning.

Such a dynamic policy problem requires flexibly designed and frequently revised policies based on new data. The policy process must be supported with institutional agility. To guide this process, the policy-makers would need to:

- estimate and continuously revise the anticipated cost trajectory of NET segments

- assess the costs of traditional infrastructure lock-in, taking into consideration the length of life-cycles and retrofitting potential

- dynamically value national supply security and global warming

- assess the value of implicit options embedded in NET for human capital, tacit knowledge and broader industrial policy in realistic terms.

Such a dynamic assessment mechanism and approach is essential in building a coherent framework to time and pace national policies in different NET segments. Some segments will be supported immediately; others will be favored on a trial basis or postponed until they become feasible.

RECOMMENDATION 11:

Turkey's NET absorption policies have to be structurally dynamic given the uncertain cost trajectories of NET, the inherent lock-in problems and the externalities of the energy domain.

Private players need as much certainty as possible given the long-term nature of NET investments. Authorities should strive to make their dynamic policy-making process as coherent and predictable as possible.

The policy process should clearly articulate its dynamic decision-making algorithm, produce and share revised data that will guide its decisions and inform investors about long-term infrastructure strategies.

In the absence of policy clarity, Turkish NET absorption attempts will not produce results and will run the risk of being perceived as arbitrary and shortsighted.

c) Policies for NET Generation

NET encompass a wide range of segments at different stages of development. Some segments like on-shore wind are effectively mature technologies where further cost and performance improvements can be shaped by the private sector. At the other extreme hydrogen fuel cells and genetically engineered microbes[65] consuming CO_2 still need long-term research and thus still require substantive public sector involvement. If the national strategy focuses on segments of the new energy domain, it is important to implement tailored polices based on the technology's stage of development and maturity.[66]

Alternatively or additionally, the NET generation strategy may focus on horizontal competences that can support a wide range of NET segments. As there is broad uncertainty about which segments will grow at what speed, it may be wiser to invest in R&D areas or human capital that can accumulate relevant input and expertise for a wide range of segments. The U.S. Department of Energy's study linking basic science and applied energy research is a useful illustration (Figure 4). For example, almost all efficient and clean energy technologies require advances in material science. Similarly, computational sciences have a broad application area among new energy technology segments. Strategic investment in horizontal competences should be a complementary approach to supporting specific segments of the NET domain.

Whether the strategy involves vertical targeting of NET segments or investment in horizontal competences, it is crucial for Turkey to establish effective mechanisms to expedite technology accumulation.

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65. Weiss, C. and W. B. Bonvillian (2009), *Structuring an Energy Technology Revolution*, MIT Press, Cambridge, MA, pp. 57-62.
66. *ETP 2010*, pp. 463-465.

Technology accumulation requires both

i. efficient streamlining of existing national competences (domestic NET policies)

ii. structuring strategically guided cross-border partnerships and collaboration between national technology constituents and their counterparts (cross-border NET policies).

The domestic and the international axes of the effort will be mutually reinforcing.

i. Achieving national effectiveness in NET

Key domestic constituents of the energy technology domain are leading technical universities, TÜBİTAK (especially MRC's Energy Institute), firms (large corporations and the SMEs), financing institutions, and related policy-making bodies (MENR, EMRA).

There are flaws in the links among these key actors. Identifying and rectifying those flaws is essential for a well-functioning national NET generation system that can deliver results. Some examples of weak links that would systematically impede a NET generation strategy are:

i. Translational research is missing

The university-industry link plays a crucial role in early-stage NET, in cutting-edge NET that has been recently commercialized as well as in NET already on a competitive downward sloping cost curve. Connecting science at the universities to potential industrial advancement is a difficult but promising policy objective. In this context, the need for *translational research* that can link the available academic competence with industry's needs is gaining traction.[67] The idea is not to narrow and constrain curiosity driven scientific research to market applications but to extract the useful applications of curiosity driven science that may be developed at low cost for market applications.[68]

67. Weiss and Bonvillian, pp. 44-45; *ETP 2010*.

68. The US research institute DARPA has responded to this need successfully in defense related domains, referenced in Weiss and Bonvillian, pp. 162-165.

ii. The IPR regime is not clear or flexible

In Turkish university-industry cooperation, the mechanisms for sharing resources and values are not clearly defined and reliably enforced. A clear, flexible and reliable IPR regime is the sine qua non of committed substantive cooperation between the universities, research institutes and the private sector.

iii. "Quality certification" mechanisms are missing

An important link in the national technology system is between corporations and funding organizations. Especially SMEs' lack of track record is a problem for their financing needs. Internationally recognized mechanisms for quality certification are likely to address this structural problem in the corporate-funding nexus.

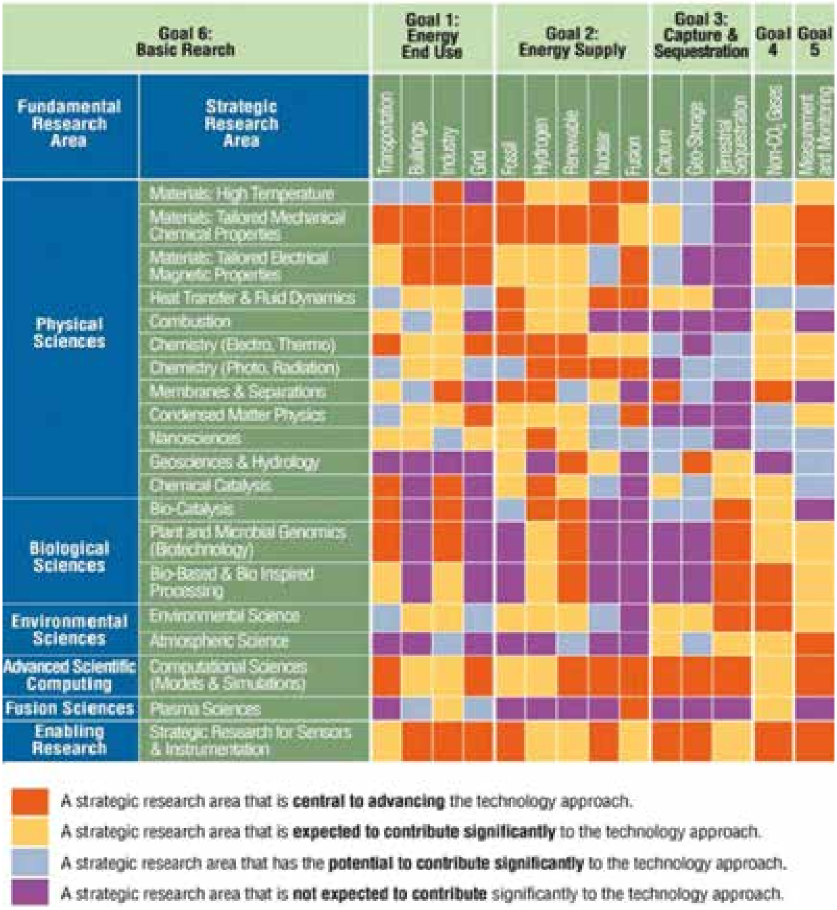
iv. Public procurement and standard-setting policies are not targeted

On the demand side of new technologies[69], untested new players face a challenge in gaining market acceptance, thus fail to improve performance and achieve cost reductions through scale. The public sector has a dual role in addressing this structural flaw. It can use narrowly defined and well-managed procurement policies with clear exit clauses. It can also shape private demand by setting standards and launching mechanisms for reliably certifying new products.

Regardless of the overall strategy for NET generation, the crucial links among the key constituents that are not functioning as desired will need to be rectified and improved if any progress is to be achieved. In the absence of a functioning domestic technology ecosystem, even the most elaborate NET generation strategies are unlikely to succeed.

69. The recent technology policies in Korea and Finland integrate supply and demand side policies whereby companies that receive R&D grants also qualify to benefit from favorable procurement support, OECD (2010), *The OECD Innovation Strategy: Getting a Head Start on Tomorrow,* OECD, Paris (hereinafter referred to as *OECD Innovation Strategy 2010),* p.113.

FIGURE 4: Links Between Basic Sciences and Applied Research Areas



Source: The National Academy of Sciences (NAS)

ii. Achieving cross-border collaboration in NET

Joining the global NET sector is not a simple process. Many nations are pursuing the same objective. It is important to expedite progress and leapfrog competitors where possible.

Collaboration with global competitors in early-stage and mature NET will require a different set of policies:

1. Collaboration in early-stage NET

For pre-competitive stage technologies, cooperation with international universities and RDI (Research, Development and Innovation) centers is viable. In some cases, companies may also find it in their interest to join such cooperation to benefit from a wider range of sources. Loosely structured arrangements like Knowledge Networks (KN) may serve as an instrument for Turkish companies and academic institutions to take part in early stage technologies.[70]

An alternative model for early-stage technology cooperation is to join patent pools in the designated area of NET. However, that would require Turkish universities and corporations to develop relevant patents in the designated technology area.

Participation in KNs or patent pools in early-stage technologies requires focused national knowledge production in selected areas. Such mechanisms also demand clarity about how the commercial benefits of cooperative efforts will be shared. A clear and reliable IPR regime is again critically important.

Achieving focused, high-caliber knowledge collaboration in early-stage NET is directly related to the efficiency of the domestic technology ecosystem both in terms of its ability to focus and to deliver results.

2. Cross-border collaboration in mature technologies

More mature NET typically have strong global incumbents in the sector. Both the wind and solar energy manufacturing industries are already heavily concentrated.[71] It is not easy to break into such markets. Commercial partnerships driven by clear corporate profit objectives are needed to drive these efforts.

70. See *OECD Innovation Strategy 2010*, pp. 149-150 for KNs. KNs are successfully implemented in health sciences.

71. In 2006, ten turbine companies provided 95% of all new turbines, four firms supplied 75% of the demand, referenced in Weiss and Bonvillian, p. 83.

There is a range of possibilities, which should be evaluated for each NET segment separately. Joining the global value chain of the incumbents with or without a licensing scheme is a possible route, but it would require strong local manufacturing firms with a sound track record. Joint Ventures (JV) are the preferred mechanism to join the global value chain in China; however, such transactions typically require market size leverage. Turkey's market size is unlikely to provide similar leverage, although its expanding market reach in its region may become an important factor.

Acquiring foreign companies that are already in the technology value chain is also a possibility, but would require post-acquisition strategic and managerial competence for lasting success.

Attracting foreign companies' R&D efforts to Turkey is also a feasible collaborative corporate approach that should be considered.

Creating the context and mechanisms for cross-border cooperation and partnerships in NET is a complex policy task. The policy-makers would need to undertake policy initiatives including:

i. Invest in talent that is the key element of any technology partnership

ii. Implement a clear, flexible and reliable IPR regime and expand national regulatory and legal capacity by investing in TPI and the patent courts

iii. Implement mechanisms for patent generation that can position national players to take part in pre-competitive early stage technologies

iv. Implement reliable[72], practical incentives and subsidies for targeted NET in Turkey and promote the availability of such incentives internationally[73]

72. The German solar PV sector was initially financed by US VC but positioned in Germany due to subsidies, referenced in Weiss and Bonvillian, p. 68.

73. The Turkish science park legislation and related laws provide generous subsidies to technology initiatives but there is no informed promotion of these subsidies as a coherent strategy to attract foreign R&D operations.

v. Structure subsidies to specifically incentivize collaborative corporate efforts that fit in with the national NET strategy

vi. Establish commercial mechanisms to aid SMEs in cross-border technology cooperation in NET

vii. Seek harmonization of NET product standards and regulations at the bilateral and multilateral level to help the growth potential of national actors.

RECOMMENDATION 12:

Developing a Turkish NET sector is a technology and industrial policy objective and should be treated as such.

Technology and industrial policy is first and foremost a systems problem. The policy framework should focus on national technology generation and commercialization structures and systems in the NET domain.

Given the nascent state of the Turkish NET industry, any national NET generation strategy should incorporate coherent mechanisms to facilitate and to encourage cross-border collaboration.

d) Institutional Recommendations in NET Absorption and Generation

The preceding discussion highlights various components of policy initiatives that would propel Turkey's NET absorption and generation competence forward. However, much of the work that is described will demand new institutional capacity.

The Task Force recommends three new institutional structures.

The two institutional needs identified correspond respectively to the technology adoption and technology generation policies. The former set of issues is normally under the aegis of the Ministry of Energy and Natural Resources (MENR) and the latter set relates to the broad responsibility of Ministry of Industry and Trade (MoIT).

However, the identified problems and the recommended policies in the report involve many constituents and require long-term thinking. The proposed functions may not be properly undertaken under the pressures of daily governance and are better structured as new institutions close to, but at arm's length from the Ministries.

The third proposed institution addresses specifically the technical issue of crafting regulations for NET adoption policies. That function is best situated within the MENR where the relevant policy decisions are made.

1. *Center for Policy Consistency and Foreseeability in NET Deployment*

The problem with NET policies is that they cover a very wide range of industries and technology segments. The various policies applied in these segments do not appear to have a broad conceptual framework that provides coherence and foreseeability to the investors. Even the budgetary impact of each policy item is difficult to track and compare. There is no conceptual or numeric benchmark that will allow evaluation, criticism or endorsement of different policies.

A focused policy analysis institute should be established to develop the conceptual framework and the metrics for quantifying the expected benefits and risks of each policy proposal by the MENR.

Based on the overall national energy objectives, the institute should be able to judge the relative merits of various NET support policies in terms of cost and expected utility. That would allow the public and interested parties to judge the myriad policy initiatives and their expected effectiveness in fulfilling claimed objectives. The conceptual framework proposed in this report is a preliminary example of such an effort.

The institute could also advise the MENR with respect to the appropriate policies in each NET segment based on the conceptual framework it has developed and shared with the public. Transparency of the conceptual analysis and measurements will enable a much more informed debate. Furthermore, it would provide continuity, predictability and reliability in an industry that is rife with inherent technical uncertainty.

Such an institute should be independent, focused and small. It should employ high caliber staff. Its main asset should be its intellectual competence and credibility.

2. *Committee for Advancing the Turkish NET Industry*

As discussed before, developing knowledge and manufacturing competence in NET will require the coherent cooperation of national constituents and effective collaboration with international partners. The NET generation ecosystem that can achieve these dual objectives would demand the cooperation of technical universities, TÜBİTAK, large corporations, SMEs, banks, MENR, MoIT and even the Ministry of Foreign Affairs (MoFA). The Committee should be able to conceptualize the ecosystem, diagnose the missing links, convince the constituents to invest in those links and continuously monitor the results.

Translational research, a simple and flexible IPR regime, SME funding problems, public procurement policies, incentives for international collaboration, internationalizing the science parks are all parts of the problem.

This Committee should serve as a think-tank, as an action group among private constituents and as a public advocacy group to pursue the necessary regulatory inputs. The Committee would have a measurable objective, which is the growth of NET industries in Turkey.

As industry is at the core of the overall objective of developing a NET sector in Turkey, the Committee should be positioned within the Chambers of Industry. Given its size and reach, the Istanbul

Chamber of Industry (ISO) is the most appropriate venue. However, the Committee should have a quasi-independent structure, as it will bring together university and finance industry leaders, government officials and other experts. The Ministries should ideally be represented at the Undersecretary level.

3. *Unit for Regulation Design - MENR*

There have been many instances of ineffective rules and reversed regulations in the NET policy domain. Policy credibility is a key issue for investors as their long-term decisions are premised on the regulatory framework.

Drafting rules and regulations that will deliver the policy objective, that will ensure predictability and flexibility is a challenging effort. Especially in complex areas with inherent uncertainty and many variables, rule drafting is a tedious and technical effort that should involve specialized economists and lawyers.

Such a professional group should be established within the MENR structure with the clear and "exclusive" mandate to draft well-crafted, robust and reliable rules that can withstand the test of time and unexpected developments.

A further regulatory guarantee to investors could be provided by establishing a structure that can arbitrate disputes arising from ex-post regulatory changes, applications and controversial interpretations. However, such an effort may entail legal complexities and requires further analysis.

RECOMMENDATION 13 - INSTITUTIONAL:

The report identifies and describes systemic gaps in Turkish policy-making with respect to NET adoption and generation objectives.

The Task Force recommends three new institutional structures to assume responsibility for addressing those gaps:

i-*Center for Policy Consistency and Foreseeability in NET Deployment* to provide independent analysis for coherence and continuity in NET adoption policies and to advocate and facilitate policy predictability in an inherently uncertain sector

ii-*Committee for Advancing the Turkish NET Industry* to serve as a coordinating body among industry, government, banks and experts to create a policy ecosystem to advance Turkish NET knowledge and manufacturing sectors

iii-*Unit for Regulation Design* to serve as a core professional body within the MENR with a clear and "exclusive" mandate to draft accurate, reliable and robust rules and regulations related to NET that can withstand the test of time and unexpected circumstances

VI- NUCLEAR ENERGY: "GLOBAL SECURITY AND SAFETY DISCONTINUITY"

Nuclear energy provided around 12% of the world's electricity supplies and 4,9% of total primary energy used worldwide in 2011.[74] However, this global ratio can be misleading, as nuclear power is regionally concentrated. Nuclear power generates 25,7% of electricity supplies in Western Europe, 18,8% in North America, 18,7% in Eastern Europe, 2,2% in Latin America, 2% in Africa, and 1,8% in Middle East and South Asia.[75]

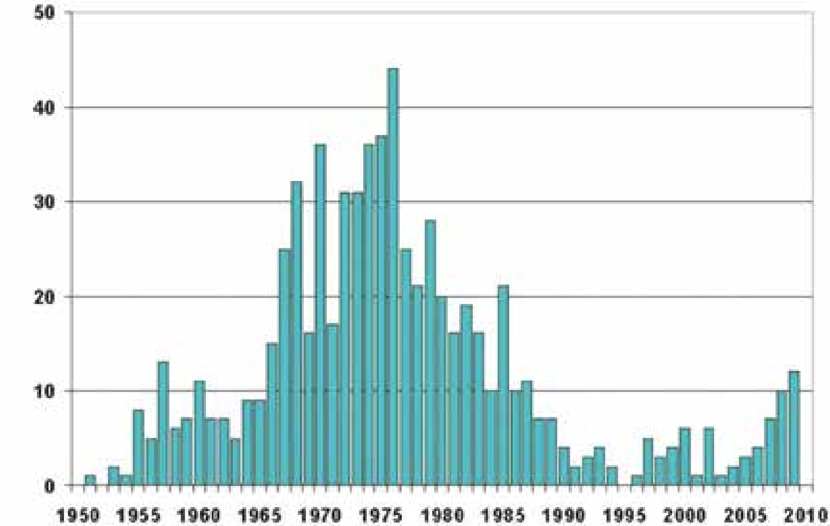
Nuclear's share in the primary energy supply has fluctuated significantly over the past 60 years. It has increased from 0,5 in 1970 to above 7% in the 1990s and declined to 5,7% by 2006.[76] Annual nuclear plant construction starts have dropped from their peak of 40 in the 1970s to 0 in the 1990s (Figure 5). Prior to the recent Fukushima accident, there was renewed interest in nuclear power driven by increasing energy demand, higher fossil fuel prices, climate change concerns and the fading memory of the Chernobyl and Three Mile Island incidents.

74. *BP Statistics, 2012*.

75. IAEA (2012), *International Status and Prospects of Nuclear Power*, Report by the Director General, IAEA, Vienna 2012 (hereinafter referred to as *ISPNP, IAEA 2012*), p. 3.

76. IAEA (2010), *International Status and Prospects of Nuclear Power*, Report by the Director General IAEA, Vienna (hereinafter referred to as *ISPNP, IAEA 2010*), p. 5.

FIGURE 5: Number of Nuclear Plant Construction Starts, 1950 to 2010



The renewed interest is widespread and goes beyond existing nuclear power states. There are currently 29 nuclear power states. IAEA reports that 65 new countries are presently showing interest in nuclear power. Prior to Fukushima, IAEA expected 25 new countries to have their first nuclear power plant in operation by 2030 in the high projection and 10 countries in the low projection scenarios. Considering that only three nations have joined the nuclear power group in the 25 years after the 1986 Chernobyl disaster, the anticipated expansion of nuclear power is significant.[77] Of the 65 countries expressing interest, 21 are in the Asia and Pacific region, 21 are in Africa, 12 in Europe and 11 in Latin America.

Admittedly, expanding global demand for nuclear energy is encouraging from a global emissions perspective. However, nuclear power generation introduces potential risks and discontinuities to the energy domain that is distinct from all other energy sources: the risk of accidents and the risk of nuclear proliferation. The Chernobyl, Three Mile Island and the recent Fukushima episodes have forced all global actors to reconsider the role of nuclear plants in power

77. *ISPNP, IAEA 2010*, pp. 6-7.

generation. The transnational nature of the radiation threat makes it a global issue.

The second risk, nuclear proliferation, is a global catastrophe scenario that is arguably on par with the global warming risk.[78] The enrichment and reprocessing technologies used in nuclear fuel generation are open to abuse by those who are intent on building nuclear weapons. The global expansion of nuclear power may facilitate proliferation at great risk to humanity.[79] If that risk is ever realized, it will almost certainly be a turning point for the nuclear energy industry. A security failure anywhere around the world is likely to change the global perception of nuclear power with unpredictable regulatory and economic impact for all nuclear power states. A "proliferation Chernobyl"[80] is likely to be a major discontinuity in every aspect of nuclear power generation.

The current global nuclear regime is shaped by the Nuclear Non-Proliferation Treaty (NPT), which came into force in 1970. Currently, 189 nations are parties to the NPT. The Treaty allows signatory states to develop peaceful use of nuclear energy in return for committing not to develop nuclear weapons or explosives and to allow IAEA verification. However, under the NPT, the right to peaceful use of nuclear power entitles signatory nations to uranium enrichment and plutonium reprocessing facilities. Those same facilities can be used to produce weapons grade uranium and a rapid increase in enrichment capability around the world may constitute a serious proliferation risk. Increasing demand for nuclear power around the world may generate broader demand for enrichment capabilities, which could in turn

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78. "The problem of nuclear weapons is at least equal to that of climate change in terms of gravity and much more immediate in its potential impact", quoted in ICNND (International Commission on Nuclear Non-Proliferation and Disarmament) (2009), "Eliminating Nuclear Threats: A Practical Agenda for Global Policy Makers", Co-Chairs: Gareth Evans & Yoriko Kawaguchi, ICNND, Australia (hereinafter referred to as "Evans Report").
79. Socolow, R. and A. Glaser (2009), "Balancing Risks: Nuclear Energy and Climate Change", *Daedalus* 138, No. 4 (Fall 2009), pp. 31-44.
80. Deutch, J., A. Kanter, E. Moniz and D. Poneman, "Making the World Safe for Nuclear Energy", *Survival* 46, No. 4 (Winter 2004-2005), pp. 65-80.

increase the global proliferation risk. Devising and implementing a global framework to ensure security of expanding nuclear power and to limit proliferation risk is still an unresolved problem.

Given the safety and proliferation threats, national strategies and policies regarding nuclear energy should carefully take into consideration the implications of such risks that may generate a global discontinuity in the use of nuclear power.

In addressing Turkish nuclear energy policy, the report evaluates nuclear power with respect to Turkey's main energy policy objectives. It also analyzes the impact of a possible global safety/ security discontinuity for each objective. The discussion on nuclear energy concludes with a summary of policy implications.

a) Does Nuclear Energy Lower National Energy Costs?

Nuclear energy is distinct from other base-load power supplies like natural gas and coal because capital investment constitutes the bulk of the cost whereas the fuel cost is minimal. The fuel cost for electricity from nuclear energy is estimated as low as 2-4% of total.[81] On the other hand, fuel costs can represent as much as 80% of the electricity produced by gas powered plants. Electricity from coal is an intermediate case.[82] The share of fuel costs would obviously change with fuel prices, but the cost structures are fundamentally different between nuclear and gas/coal plants.

This structural difference has significant implications for the overall energy bill. Nuclear energy has a relatively stable cost structure once the investment is made whereas cost of gas and coal based electricity fluctuates with fuel prices. When gas or coal prices decline, nuclear may become uncompetitive and vice versa. Nevertheless, including nuclear in the overall mix reduces volatility. It is effectively a

81. MIT (2010), *The Future of the Nuclear Fuel* Cycle: *Summary Report,* An Interdisciplinary MIT Study, Cambridge, MA, p. 4.
82. Joskow, P. and J. E. Parsons (2009), "The Economic Future of Nuclear Power", *Daedalus* 138, No. 4 (Fall 2009), pp. 45-59.

mechanism to lower the overall volatility of the national electricity bill. However, if its weight in the overall mix becomes high, it would lock in an inertial average cost that may be disadvantageous if alternative electricity sources become more competitive. Policy-makers should set the balance based on national risk-appetite and their energy price foresight.

A key feature of the nuclear power cost structure is that it relies heavily on the anticipated life of the plant. As the initial cost is very high, spreading it over as many years as possible reduces the yearly cost burden. Under normal circumstances nuclear power plants can last as long as 60 years. However, major national or international discontinuities would have a major adverse effect on this calculation. A safety or proliferation related catastrophe somewhere around the world could interrupt or, if there is a technical correlation with the incident, could even terminate power generation at a plant in another part of the world. The initial capital investment would then have a significant cost impact. Interruptions or discontinuities will have a much higher adverse cost impact on nuclear relative to gas or coal powered plants.

Safety and security issues related to nuclear power generation also differentiate it from gas and coal. Evolving safety standards, waste management, and final decommissioning are all important cost elements that are spread over a long horizon. Therefore, the stakeholders carry a range of commercially relevant risks throughout the long life cycle of the nuclear power plant. Delineating and appropriating those risks can be a complex commercial challenge at the initial investment stage. Not addressing those complexities at the outset may generate difficulties as the risks and associated costs materialize. As the details of the contract for Akkuyu nuclear plant are not publicly available, it is not possible to assess how these risks have been apportioned.

A possible safety or security discontinuity could trigger a major adverse regulatory or legal scenario. The commercial implications for such contingencies should be contractually specified to avoid lengthy and harmful legal processes.

b) Does Nuclear Power Serve Energy Supply Security?

Nuclear energy does not rely on fossil fuels and therefore reduces the import dependence of fossil fuel consuming nations. However, nuclear power relies on enriched uranium or reprocessed plutonium. Securing the fuel for nuclear plants is an energy security problem, albeit with very distinct dynamics.

Nuclear fuel is available in a relatively well-functioning market and nations can undertake long supply agreements. It is a fuel that diversifies the overall energy supply portfolio.

However, nuclear fuel supply may also create bilateral dependence as in other fuels. The current plans for nuclear power investments in Turkey together with gas and oil relations already set a context of dependence. That context is increasing the correlation among Turkey's gas, and nuclear supply security and undermining the diversification benefit of the nuclear investment. It is a very sensitive risk calculation that needs to be assessed in detail. The n-1 supply security formulation discussed before[83] for natural gas may be broadened to include all electricity supply sources.

Finally, to improve supply security, a nuclear power nation could develop its own enrichment facilities. In that case it would also need to secure the raw uranium for absolute supply security. Both steps are commercially and politically complex and would require political commitment.

Given the current partners in question, advocating nuclear power for Turkey on the basis of absolute supply security may be misleading. Nevertheless, it will contribute to the diversity of the Turkish energy mix.

A global proliferation discontinuity would exacerbate the supply security risk. A "proliferation Chernobyl" could trigger a freezing of all enriched uranium supplies. Preempting such a contingency or having sound mechanisms to weather such a crisis should be part of the Turkish nuclear power strategy and planning.

83. See section IV(b)(iii)(1.1).

c) Will Nuclear Power Improve Turkey's Carbon Intensity Profile?

As nuclear power is carbon-free it will certainly contribute to a reduction of carbon intensity. However, as noted before, global public opinion may perceive nuclear safety or proliferation risk on par with global warming on the global agenda. It is of paramount importance that Turkey approaches and treats both issues as part of its broad global responsibilities.

If proliferation or a new safety crisis were to occur, the global political and public opinion repercussions would overwhelm the global warming agenda for some time. Turkish policy planning should be well prepared for that contingency.

d) Does Nuclear Power Enhance Turkey's Technology and Human Capital Capacity?

As discussed in NET, benefiting from technology investments in terms of tacit knowledge or human capital is not automatic. It requires informed and well-reasoned policies that would allow the absorption of nuclear knowhow in the Turkish technology domain. It also requires contractual mechanisms that would force the technology provider to share knowhow and train people.

There is currently no publicly available convincing information about contractual effective technology transfer provisions or plans for sustained investment in absorptive capacity. In their absence, nuclear power's promised technology externalities are not credible and constitute at best a weak argument in favor of nuclear investments.

e) Does Turkey Need a Safety & Non-Proliferation Strategy?

The global renewal of interest in nuclear power and the anticipated increase in the number of new nuclear power countries constitute a serious challenge for the global non-proliferation agenda. Given the right to enrichment and reprocessing under the NPT, some of the new players may opt to invest in such facilities. The world does not have a functioning nuclear power governance mechanism to address rapid dissemination of enrichment capabilities.

Turkey cannot merely be a consumer of the global nuclear security or the safety regime. Another Fukushima or a possible "proliferation Chernobyl" incidence is likely to reshape the context of global nuclear power and will inevitably impose costs on nuclear power states. As discussed, it would have serious repercussions for Turkey's energy policies in terms of cost, supply security and even carbon intensity targets.

As Turkey embarks on the road to becoming nuclear power, it has to become an active player in and contributor to the global nuclear safety and security regime. It is a complex technical policy area that attracts some of the best minds around the globe.

With respect to proliferation, some argue for strict multilateral control of all enrichment and reprocessing facilities (ERF), including the current national facilities.[84] Some argue for creating incentives to freeze the development of new ERF for a fixed period until the world agrees on a viable regime for nuclear fuel supplies. Such incentives range from subsidized fuel sales to globally shared ERF R&D efforts to multi-layered supply guarantees.[85] Some others argue for multi-lateralization of the nuclear fuel cycle as well as seeking technology solutions in proliferation resistance[86] or decreasing the attractiveness of nuclear materials for weapons[87].

The menu of possibilities is vast, encompassing sophisticated technology solutions, complex international diplomacy, well-designed economic incentives and credible supply security measures.

84. El-Baradei, M., "Nuclear Energy: The Need for a New Framework", Statements of Director General, IAEA, 17 April 2008.
85. Deutch, Kanter, Moniz and Poneman "Making the World Safe for Nuclear Energy".
86. Evans Report, pp. 126-127.
87. *The Future of the Nuclear Fuel Cycle*, p. 15.

Turkey has to invest intellectual and diplomatic capital in the global non-proliferation effort as an integral part of its strategy to invest in nuclear energy. Its regional role and international standing may prove to be a useful asset in devising and implementing a reliable nuclear power governance regime. Preventing a proliferation-Chernobyl event is in the best interest of Turkey's nuclear energy policy, its broad security objectives, and its global responsibilities.

Even if it fails in the effort, Turkey has a strong interest in being globally recognized as a responsible and active actor in international nuclear non-proliferation and nuclear safety discussions. Turkey should have the global standing and the intellectual preparedness to take part in designing and enforcing emergency measures that would be necessary in the aftermath of a crisis.

Nuclear non-proliferation and safety issues lie at the interface of technology, policy and international politics. Turkey should launch the institutional structures that can effectively function at this interface. A high-caliber Nuclear Research & Policy Center should be instituted both to inform the official policy formulations and also to make significant contributions to the global nuclear debate. The center could be positioned within a university[88] or may be structured as an independent institution. It should bring together experienced policy analysts and technology experts to develop coherent, comprehensive and pragmatic strategies that could advance the global initiatives. In parallel, the Ministry of Foreign Affairs should have a well-staffed department that "exclusively" focuses on the international nuclear security regime. The Nuclear Research & Policy Center and the specialized group within MoFA should jointly pursue an active, creative, useful and recognized role for Turkey in the global safety and security debates and policy initiatives.

88. The Belfer Center at Harvard University may provide an appropriate model for such a center although it has a wider agenda beyond the nuclear safety and security issues.

RECOMMENDATION 14:

Turkey's nuclear power strategy is justified on the basis of cost, enhanced security, carbon emission reductions and technology transfer. There is a legitimate debate on each one of these justifications.

However, the current debate ignores potential global safety and proliferation crises that could create significant discontinuities in global nuclear power generation. That would upset all current energy security, cost and emission considerations.

Mitigating the risk of a safety discontinuity requires competent, close oversight during both the operation and the decommissioning of the nuclear facilities. An independent oversight/regulatory agency with sufficient funding and expertise should regulate and monitor every stage of the process.

More importantly, Turkey has to invest intellectual and diplomatic capital in the global non-proliferation and safety effort as an integral part of its strategy to invest in nuclear energy. Turkey should become globally recognized as a responsible actor in international nuclear non-proliferation and safety debates and initiatives.

RECOMMENDATION 15 - INSTITUTIONAL:

The report identifies and describes gaps in Turkish policy-making with respect to nuclear power.

The Task Force recommends two new institutional structures to assume responsibility for addressing those gaps:

i-*Nuclear Research & Policy Center,* an independent policy institute to inform the official policy formulations with respect to nuclear proliferation and safety issues and to make contributions to the global nuclear safety & security debate.

ii-*Unit for Nuclear Proliferation,* to be established within the Ministry of Foreign Affairs to "exclusively" engage in the international diplomatic efforts related to the international nuclear security regime.

CONCLUSION

Fossil fuels, renewables, nuclear power and efficiency measures are all parts of the interconnected energy problem. Myriad shifts and discontinuities impact segments of this complex system with typically unpredictable timing. The shock in one segment then reverberates through and affects the whole energy context. Policy-makers have to optimize and re-optimize continuously on this shifting sand.

This picture and challenge is unlikely to change. A system as large, interconnected and dynamic as energy will always be perturbed, strained and shaped by unforeseen influences.

As such, trying to predict these developments and weathering through them will always be a part of the policy process. In this process, one can forecast and manage trends within the existing structures or alternatively, attempt to predict and survive discontinuities that change the structure itself. This report's focus has been on the latter quest motivated by a desire to make a more enduring contribution.

Looking forward, the ability to survive structural shifts on a sustained basis can only be built on "intellectual competence" and "institutional capital". Therefore, in conclusion, it is worth highlighting these two fundamental priorities as the underlying drivers of any effective policy thinking or implementation in the future.

Intellectual capacity formation should be at the core of energy policy planning. As the report amply illustrates, energy is quintessentially a multi-disciplinary domain that requires the ability to understand and synthesize political, economic, technical and social factors. Expanding research and educational programs that treat energy issues as an integrated problem rather than a combination of disparate parts has to be an indispensable component of any policy vision. Investing in well-trained cohorts of experts and policy-makers is the sine qua non of building Turkey's policy capacity to chart through long-term energy challenges. Without a constant flow of bright informed minds, none of the policy ambitions of this or any other report can be brought to life.

Similarly, as the report highlights in its various recommendations, institutional capital will be critical for shaping, implementing and monitoring policies that have a long-term structural focus. Institutional capacity, both in the public and private sector, is required to maintain an intellectual commitment to a long-term policy horizon and to provide the requisite political discipline for anchoring short-term policy impulses to Turkey's long-term energy thinking. Although well-trained individuals are essential in making the critical intellectual contributions to energy thinking, it is equally important to design reliable institutions which can provide the much-needed continuity in energy policy.

Energy is and will remain central to human existence and progress. Its role in national and global affairs will continue to be shaped by the convoluted interplay of human ingenuity, rivalry and natural constraints. Sailing through that intrinsic volatility in safety and with a clear purpose is an overwhelming policy challenge. We hope this report proves to be a modest contribution to that journey.

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UNIT ABBREVIATIONS AND ACRONYMS

bcm	billion cubic metres
bn	billion
BOTAŞ	Petroleum Pipeline Corporation
BP	British Petroleum
BTC	Baku-Tblisi-Ceyhan Crude Oil Pipeline
CCS	carbon capture and sequestration
CNG	compressed national gas
CO_2	carbon-dioxide
DARPA	U.S. Defense Advanced Research Projects Agency
EIA	U.S. Energy Information Administration
EMRA	Energy Market Regulatory Authority, Republic of Turkey
ERF	enrichment and reprocessing facilities
ESPO	Eastern Siberia-Pacific Ocean oil pipeline
ETP	Energy Technology Perspectives
EU	European Union
GDP	gross domestic product
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IEEP	Implementing Energy Efficiency Policies
IMO	International Maritime Organisation
IPR	intellectual property rights
ISO	The Istanbul Chamber of Industry
ISPNP	International Status and Prospects of Nuclear Power
ITU	Istanbul Technical University

JV	joint venture
kg	kilogram
km	kilometer
KN	knowledge network
LED	light-emitting diode
LNG	liquefied natural gas
LPG	liquefied petroleum gas
m	meter
mb/d	millions of barrels per day
MENR	Ministry of Energy and Natural Sources, Republic of Turkey
METU	Middle East Technical University
MIT	Massachusetts Institute of Technology
MoFA	Ministry of Foreign Affairs, Republic of Turkey
MoIT	Ministry of Industry and Trade, Republic of Turkey
MRC	TÜBİTAK Marmara Research Center
Mtoe	million tonnes of oil equivalent
NAS	The National Academy of Sciences
NET	New Energy Technologies
NPT	Nuclear Proliferation Treaty
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
ppm	parts per million
PPP	purchasing power parity
PV	photovoltaics
RD	research and development

RD&D	research, development and demonstration
RDI	research, development and innovation
SMEs	small and medium enterprises
TANAP	Trans-Anatolian Natural Gas Pipeline
tn	trillion
toe	tonne of oil equivalent
TPAO	Turkish Petroleum Corporation
TPES	total primary energy supply
TPI	Turkish Patent Institute
TSI	Turkish Statistical Institute
TÜBİTAK	The Scientific and Technical Research Council of Turkey
UK	United Kingdom
US	United States
USD	United States dollar
WEO	World Energy Outlook
WTI	West Texas Intermediate
VC	venture capital

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Technical University (ITU) ARI Teknokent. During this period, Mr. Karakullukçu also served as the senior advisor to the President of ITU, the Coordinator of the Law Technology and Policy MSc programme and the strategic advisor at the ITU Remote Sensing Facility. He was a member of the academic staff at the LSE and ITU. Earlier in his career, he worked as a specialist in structured finance at the London and Istanbul offices of an international investment bank (1992-1994). His previous academic work includes research commissioned by the IMF and the World Bank on the dynamics of Turkish debt markets. Mr. Karakullukçu received his B.S. in Electrical Engineering and in Economics at MIT, his MSc in Finance at the LSE and his J.D. at Columbia University. He is a member of the New York State Bar.

Sönmez Köksal

Sönmez Köksal is a retired career diplomat who has served as the Ambassador of Turkey to France and Iraq and as Permanent Delegate to the Council of Europe. He was Undersecretary of State in charge of the Turkish National Intelligence Organization from 1992 to 1998. Mr. Köksal has served in several posts at the Ministry of Foreign Affairs, including as Deputy Director General in charge of Multilateral Economic Relations, Deputy Permanent Delegate to the EEC, Director of the Middle East and Africa Department and Director of the Policy Planning Department. Mr. Köksal was until recently President of the Board of Trustees of the Istanbul Commerce University and a member of the academic staff at Işık University. He is currently a member of the Wise Men Center for Strategic Studies and a member of the High Advisory Board of Global Political Trends Center in Istanbul. Mr. Köksal is a graduate of the Faculty of Political Science of Ankara University.

C. Tanıl Küçük

Cemal Tanıl Küçük was born in Zonguldak, in 1956. He graduated from İstanbul University, Faculty of Law. Mr. Küçük became a member of the İstanbul Chamber of Industry (ISO) Assembly in 1981 for the first time. First elected for the Board in 1993, he was subsequently and repeatedly elected President of the Board of Chamber, for the third time in February in 2009. Since May 2007, he is the Chairman of Istanbul Chamber of Industry. C. Tanıl Küçük, who was the Chairman of TOBB's Council of Chambers of Industry from 2005 to 2009, assumed the Vice Presidency of TOBB in 2009. Mr. Küçük also served in the Economic Development Foundation (İKV) as a Board member and a delegate in the General Assembly between 1995-1999. Mr. Küçük is the Chairman of the Board of Directors of Elit Chocolate and Confectionery Company.

Erol Memioğlu

Mr. Memioğlu was born in 1954. He studied Petroleum Engineering at the Middle East Technical University. He started his career in 1979 as Senior Engineer at TPAO and continued his career there as the Chief Engineer, Production Manager, President of International Group, and President of Turkish Petroleum Overseas Co. respectively, until 1999. Between 1999-2003, he worked as the Assistant to the President of the Energy Group at Koç Holding A.Ş. Between 2003 and April 2004, he worked as the Executive Board Member at Energy Group Companies. Mr. Memioğlu has been the President of the Energy Group, Koç Holding A.Ş. since May 2004.

Muhsin Mengütürk

Muhsin Mengütürk is a member of the Board of Directors of Doğuş Holding, a leading Turkish group of companies active in banking, construction, media, automotive, tourism and energy sectors. He served as the Chairman of the Capital Markets Board of Turkey from 1997 to 2000. Prof. Mengütürk has held numerous executive roles in the finance sector. Prior to 1990, Professor Mengütürk taught at Bosphorus University and Istanbul Technical University (ITU). He has authored a textbook on international finance. Prof. Mengütürk is a graduate of the American Robert College in Istanbul where he completed his undergraduate degree in Mechanical Engineering. He received his M.S. and PhD at Duke University, again in Mechanical Engineering.

İlhan Or

İlhan Or was born in Istanbul, in 1951. He obtained his B.S., M.S. and PhD degrees from the Industrial Engineering Department at Northwestern University. He has been a faculty member at Boğaziçi University's Industrial Engineering Department since 1976; he has also held various administrative positions at Boğaziçi University, including the Directorship of the Graduate School of Science and Engineering (2005 -), Senatorship in the University's Senate (2005 -) and Chairmanship of the Industrial Engineering Department (between 1994-98 and 2003-06). During 1983-84, he worked at Syracuse University and at the University of Maryland as a visiting professor. He received his Associate Professor and Professor titles in 1984 and 1991 respectively. İlhan Or's major fields of research and teaching interest are linear optimization, risk analysis and management and operations research applications in energy planning. He has published many articles and made numerous presentations in international scientific journals and meetings, in these areas. He has also conducted continuing education and training seminars and worked as a consultant to industry in his fields of interest. Mr. Or served as an Associate Editor of the Naval Research Logistics Journal between 1993-2004. He is a founding member of the Energy Economics Association of Turkey and of the Solid Waste Turkish National Committee; he is a member of the Turkish Statistics Society and the Operations Research Society of Turkey.

Ayşe Yasemin Örücü

Working on energy and climate policy in the Ministry of Energy and Natural Resources, Ayşe Yasemin Örücü has been involved in international climate change negotiations for the last five years. She worked on the first National Communication to the UNFCCC, 1990-2008 National GHG Inventory and Reports, WG on GHG Abatement in the Energy Sector, Carbon Capture and Storage Project, energy sector modelling, Decentralized Energy Production Project (WADE) and EU Environment Chapter. She also participates in climate and energy related activities under the UNFCCC, OECD, EU, IPCC and

BSEC. She was trained and has experience on policy formulation, environmental management, GHG inventories, environmental economics and law. She holds an MS and a BS degree from the Middle East Technical University, Mining Engineering Department, where she used to work as a research assistant. In 2005, she obtained an MSc degree from Oxford University's Environmental Change and Management Program, which focused on the climate and energy.

G*ülsün Sağlamer*

Gülsün Sağlamer is the former Rector of Istanbul Technical University (ITU) and a professor of architecture at ITU. She was a Board Member of the EUA (European University Association) from 2005 to 2009. She was also a member of the Steering Committe of EUA's Institutional Evaluation Programme. She is an Executive Committee Member of the International Association of University Presidents (IAUP) and President of the Community of Mediterranean Universities (CMU). She was a member of the Advisory Group of the Marie Curie Programme of the EC (2006-2011). She is a member of the Board of Trustees at Kadir Has University and the Board of ITU Development Foundation. She is on the editorial board of three international scientific journals. The American Institute of Architects (AIA) awarded her an "Honorary Fellowship" (Hon FAIA) in 2006. She has received the "Leonardo da Vinci Medal", given by SEFI (European Society for Engineering Education). Prof. Sağlamer graduated and received her PhD from the Faculty of Architecture at Istanbul Technical University (ITU).

Mustafa Tırıs

Mustafa Tırıs was born in 1965 in Izmir, Turkey. He has received a BSc in Petroleum Engineering in 1987 from Istanbul Technical University; MSc and PhD from Ege University - Solar Energy Institute, in 1990 and 1992, respectively. He joined University of Leeds, Department of Fuel & Energy during his post-doctoral studies. He started working for TÜBİTAK Marmara Research Center (MRC), Department of Chemical Engineering, as a Researcher in

1990. He worked in the Department of Energy Systems of MRC as Senior Scientist (1994-1996), as Assistant Director in Energy Systems and Environmental Research Institute (1996-2000), and as Director in Energy Systems and Environmental Research Institute (2000-2004). He was the Director of Energy Institute and acting director of Environment Institute at TÜBİTAK MRC (2004-2011). He also served as the Steering Committee Member of the Turkish Automotive Technology Platform, Member of the Turkish Energy Efficiency Coordination Committee, Member of the Committee on Research and Technology (CERT) of the International Energy Agency (IEA), Member of the NATO-CCMS Committee and Alternate Member of the NATO-SPS. He moved to private sector in 2011 and he is currently the General Manager and a Board Member at T-Dinamik Energy Investment Company.

Volkan Vural

Volkan Vural is currently the Advisor to the Chairman of Doğan Holding A.Ş., Turkey's leading conglomerate in media and energy. Mr. Vural is also a member of the executive board of TÜSİAD. As a former career diplomat, Mr. Vural has served in the Islamic Republic of Iran, the Soviet Union and subsequently the Russian Federation, the Federal Republic of Germany, the United Nations and the Kingdom of Spain as the Turkish Ambassador. Mr. Vural also assumed the duties of Deputy Undersecretary of the Turkish Ministry of Foreign Affairs, Chief Advisor of the Prime Minister on foreign policy, and Secretary General of the European Union General Secretariat. Mr. Volkan Vural is a graduate of the Faculty of Political Sciences of Ankara University.

Nigar Ağaoğulları (Project Director)

Nigar Ağaoğulları graduated from Georgetown University in 2002 with a B.S. degree in Foreign Affairs concentrating in Culture & Politics as well as minorities, and she completed a certificate programme in Muslim-Christian Relations. Nigar Ağaoğulları holds MSc degree (merit) in Social and Public Communication from the LSE with specializations in corporate communications, social psychology and corporate social responsibility. After she interned at Western Policy Center in Washington, DC; and the Turkish Mission to the UN in New York, she began her career at an international law firm, Shearman & Sterling LLP. Following her return to Turkey, she worked in her family's business as a Strategy and Business Development Coordinator and served as a consultant to several companies during her position at Medyaevi Communication Consultancy. Before joining GRF, Nigar Ağaoğulları has worked in the Strategy and Business Development Department of Doğan Holding. She is currently the Director of Studies at Global Relations Forum. She is fluent in Turkish, English and French, and conversational in Greek. Ms. Ağaoğulları is a Board Member at Trakya Flour Industry and Trade Co., Olin Vegetable Oil Products and The Koc School Alumni Association.

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