Workshop on Environmentally Friendly Technologies and Measures in the Energy Industry: potential for NAMAs

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Chinggis khaan Hotel, Ulaanbaatar, Mongolia

"Results of TNA for GHG mitigation in Mongolia and introduction to draft technology action plan"

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- Technology needs assessment (technology selection)
- Barrier analysis for selected technologies
- Draft Technology Action plan for selected technologies

TNA - Technology selection

Energy Industry: existing technology

Service	Category	Technology	Brief descriptions
Electricity supply	Fossil fuel	Combined heat and power, large scale	There are 7 Combined Heat and Power plants (CHP) in Mongolia. They produce the majority of electricity and heat energy.
		Diesel for electricity generation	The province centers which are not connected to the central grid have diesel generators for electricity supply.
	Renewable energy	Small-scale hydropower plant	There are currently 13 hydro plants operating with capacities ranging from 150 kW to 12.0 MW.
		Small-scale solar PV	Most herders have independent solar PV systems to generate electricity for using lights, radios and TVs
		Solar and wind hybrid technologies	Recently, wind power stations as well as combined Solar-Wind stations were built in some soum centers.
Heat supply	Fossil fuel	Combined heat and power, large scale	There are 7 Combined Heat and Power plants (CHP) in Mongolia. They produce the majority of electricity and heat energy.
		Heating stations for space heating and domestic hot water	Heating stations are used in province centers.

TNA - Technology selection for Energy industry sector

Service	Category	Technology
Electricity supply	Renewable energy	Large-scale dam-based hydro for electricity supply (more than 100MW)
		Large-scale run-of-river hydro for electricity supply (15-75MW)
		Medium-sized dam-based hydro for electricity supply (10-100 MW)
		Small-scale hydropower plant (up to 10 MW), including mini hydro (100 kW – 1 MW) and micro hydro (5-100 kW)
		Pumped storage hydroelectricity
		Wind turbines: on-shore, large scale
		Solar PV(off grid, grid connected, solar home system)
		Solar thermal-CSP, central receiver tower, parabolic trough collector and dish
		Biomass combustion and co-firing for electricity and heat
	Fossil fuel	Combined heat and power; large-scale
		Combined heat and power; small-scale
		Coalmine/coalbed methane recovery
		Carbon capture and storage
		Integrated gasification, combined-cycle
		Pulverized coal combustion with higher efficiency
	Other	Fuel cell for stationary applications
		Hydrogen technologies
		Downdraft energy tower
		Methane capture at landfills for electricity and heat
Heat supply	Fossil fuel	Combined heat and power; large-scale
		Combined heat and power; small-scale
		Heat only boilers for space heating and domestic hot water supply
		Coal mine/coal bed methane recovery
	Renewable	Biomass combustion for electricity and heat
		Solar heating technologies
		Heat pump for space heating and water heating
	Other	Fuel cell for stationary applications
		Hydrogen technologies
		Methane capture at landfills for electricity and heat
		Combustion of municipal solid waste for district heating

TNA - Technology selection for energy industry sector

Energy Service	Category	Technology
Electricity supply	Renewable energy	Large scale dam-based hydro for electricity supply (more than 100MW)
		Medium-sized dam-based hydro for electricity supply (10-100 MW)
		Pumped storage hydroelectricity
		Wind turbines: on-shore, large scale
		Solar PV (off grid, grid connected, solar home system)
		Solar thermal –CSP, central receiver tower, parabolic trough collector and dish
	Fossil fuels	Carbon capture and storage
		Integrated coal gasification combined cycle
		Pulverized Coal Combustion with higher efficiency
Heat supply	Fossil fuel	Heat only boilers for space heating and domestic hot water

TNA - Technology selection for energy industry sector

The major coal based technologies that are available today:

- conventional pulverized coal combustion (PC)
- circulating fluidized bed combustion (CFB)
- supercritical (SC) and ultra-supercritical (USC) PC combustion, and
- integrated gasification combined cycle (IGCC)
- carbon capture and storage (CCS) technologies. CSS technologies have not yet been commercialized.

TNA - Technology selection for energy industry sector

Costs	
Capital Costs (Construction of power/heat supply plants)	These should include both public and private capital costs.
O & M Costs (plus fuel costs)	These include costs incurred to maintain power/heating plants and fuel costs.
Cost effectiveness of mitigation	The technologies being selected are for mitigation therefore it is important to look at the cost effectiveness of the technology in terms of USD per unit of CO_2 mitigation.
Benefits	
Environmental Development Priorities	**Definition**
Reduced air pollution	Improving air quality by reducing air pollutants such as SOx, NOx, suspended particulate matter, non-methane volatile organic compounds, dust, fly ash and others.
GHG emission reduction by 2030	Reduction in GHG emission through promotion of clean energy and efficient technologies in the energy supply subsector.
Social Development Priorities	
Healthcare improvement	Reduction of health risks such as diseases or improvement of health conditions reducing health damaging air pollutants and indoor smoke.
Economic Development Priorities	
Energy supply improvement	Improved access, availability and quality of electricity and heating services.
Balance of Payments	Reduction in the use of foreign exchange through a reduction of imported oil products and electricity in order to increase national economic independence.

TNA - Technology selection for energy industry sector

Using the MCDA approach, the following technologies for the energy supply subsector were prioritized for future investigation:

- **Large hydropower plant;**
- **Wind turbines; and**
- **SC and USC coal combustion technologies**

TNA - Technology selection for residential and commercial sector

Service	***Category***	***Brief descriptions of existing technologies***
Electricity consumption	Lighting	Most consumers use energy inefficient incandescent lamps.
		Very few consumers use energy efficient compact fluorescent lamps (CFL).
	Electric appliances	Consumers use very different kinds of refrigerators and TVs. There is no control on energy efficiency of electric appliances.
	Electric motors	Most motors are of constant speed.
Heat consumption	District heating	Multi-storey commercial and residential apartment buildings and a small number of private houses are connected to district heating networks for space heating and domestic hot water supply. Insulation of buildings is poor and leaves much room for improvement for reducing energy use for heat consumption in the residential and commercial subsector.
Fuel consumption	Fossil fuel	Small water heating boilers are used in provincial centers for providing heating for households, schools, hospitals, kindergartens and other public institutions. They are of very low efficiency (40-50%) due to outdated equipment.
		Individual heat stoves, which burn coal and/or wood to meet residential heating needs, are used in peri-urban areas of cities and in rural areas.
	Renewable energy	Some individual consumers, especially in rural areas, use biomass for heating and cooking.
		There are a few cases of experimental use of heat pumps for space heating and water heating of kindergartens.

TNA - Technology selection for residential and commercial sector

Service	***Category***	***Technology***
Demand-side management for electricity	Energy saving	Building energy management system
		“Smart” appliances and home automation
		Energy efficient refrigerators
		High efficiency televisions
		Compact Fluorescent Lighting, LED
		Variable Speed Motor control
		Energy storage: Batteries
		Energy storage: Capacitors
		Energy storage: Flywheels
Heating and cooling	Energy saving technology	Ventilation: Air-to air heat recovery, demand control systems
		Improved building insulation
		High efficiency heating, venting, and air conditioning (HVAC)
		Improved coal fired heating stoves
		Energy storage technologies
Lighting	Energy saving	Compact Fluorescent Lighting, LED
		Smart controls
		Day lighting and building design
Cooking	Renewable and fuel switch	Solar heating and hybrid systems with hot water
		Solar cookers
		Biogas for cooking
		Cook stoves on biomass gasification
		LPG and LNG for household and commercial cooking

TNA - Technology selection for residential and commercial sector

Finally the following two prioritized technologies were selected for the next step investigation:

- **Efficient lighting and**
- **Improved insulation of panel apartment buildings.**

Barrier analysis

	Selected technologies	***Category of the technology***	***Remarks (classification)***
1	Large scale hydro power plants	Non-market	Publicly provided goods
2	Grid connected wind park	Non-market	Other non-market goods
3	Pulverized coal combustion technologies	Non-market	Publicly provided goods
4	Efficient lighting technology	Market	Consumer goods
5	Insulation of panel apartment buildings	Market	Consumer goods

Barrier analysis

- The barriers and measures for all five selected technologies under the two subsectors have been identified as follows:
- The TNA local consultants have prepared the long list of barriers and measures to overcome the barriers on the basis of own experience, existing studies and policy documents and UNEP RISOE Centre Guidebook “Overcoming Barriers to the Transfer and Diffusion of Climate Technologies”. The long list consists of barriers, elements of barriers and dimensions of barrier elements (see Annex I).
- The long list economic and financial barriers has been discussed with stakeholders to identify the essential barriers which definitely need to be addressed for technology transfer and diffusion to occur, and the non-essential barriers, which are to be discarded and subsequently ignored.
- All possible barriers were entered in random order in the long list, and each workshop participants was asked to give each barrier a score from 1 to 5, according to how important the barrier is from the participant’s own perspective

Barrier analysis - HPP and WP

1	Target of electricity from renewable sources in total electricity production in 2010		3-5 %
2	Share of electricity production from renewable sources in total electricity production in 2011.		1.11%
	From this	*Hydro*	*1.1%*
		Wind and Solar	*0.01%*
3	Target of electricity from renewable sources in total electricity production in 2020		20-25%
4	Expected total electricity consumption in 2020 (million kWh)		7800.0
5	Expected amount of electricity from renewable sources corresponding to 2020 target (million kWh)		1560.0

According to the government policy Shuren HPP (300 MW, Egiin HPP (220 MW) and Orkhon HPP (100 MW) will be constructed in the level of 2020. The electricity consumption of HPPs will be 1372 million kWh which will be 17.5 % of total electricity consumption.

In order to implement the target of National renewable energy program, Energy regulatory committee gives licenses to 5 private companies for construction of wind parks with total capacity 354.4 MW. The electricity generation of WPs will be 708 million kWh. The share of electricity generation from WPs will be 9.1 %.

TNA – Barrier analysis

Large scale HPP

	Barriers	Average Scores	Rank
	Economic and financial		
1	Lack of or inadequate access to financial resource	2.6	4
2	High capital cost	3.3	2
3	High transaction costs	3.1	3
4	Inappropriate financial incentives and disincentives	3.4	1
5	Uncertain financial environment	2.4	5
6	Uncertain macro-economic environment	2.2	6

TNA – Barrier analysis

Large scale HPP

	Barriers	Average Scores	Rank
	Market failure/ imperfection		
1	Poor market infrastructure	3.1	9
2	Low competition	3.3	5
3	Restricted access to technology, no experience	2.1	17
	Policy, legal and regulatory		
4	Insufficient legal and regulatory framework	2.6	13
5	Inefficient enforcement	4.0	2
6	Policy intermittency and uncertainty	3.9	3
7	Highly controlled energy sector	3.3	6
	Network failures		
8	Weak coordination among actors favoring the new technology	3.5	4
9	Incumbent networks are favored by legislation	4.6	1
	Institutional and organizational capacity		
10	Lack of professional institutions	3.1	7
	Human skills		
11	Inadequate training facilities	2.8	10
12	Inadequate personnel for projects designing	2.7	12
	Social, cultural and behavioral		
13	Traditions and habits	2.5	15
	Information and awareness		
14	Lack of confidence in new climate technologies	3.1	8
	Technical		
15	Technology not familiar in Mongolia	2.0	18
16	Poor O&M facilities	2.3	16
17	System constraints	2.6	14
	Other		
18	Environmental impacts	2.7	11

TNA – Barrier analysis

Common barriers for HPP, WP and TPP

Common barriers regarding the policy, legal and regulatory aspects are

- lack of long-term political commitment and uncertain government policies (political risks for investors);
- lack of government control for implementation of laws and regulations;
- government or utility monopoly of energy sector.

Common barriers regarding the market and network aspects are

- underdeveloped competition,
- insufficient coordination between relevant ministries and other stakeholders.

Regarding the large scale HPP technology, policy-related barriers have first priorities.

- The stakeholders participated in the barrier analysis gave the highest score 4.75 (from maximum 5) to the barriers “Lack of long-term political commitment” followed by barriers “Officials make decisions on their own will”, “Uncertain government policies (political risks for investors)”, and “Insufficient willingness or ability to enforce laws and regulations”
- Decision makers and all the experts in the energy sector understand the need for developing large scale hydro power plants in the current energy system of Mongolia. However, these kinds of projects are not moving forward and materialized due to political reasons and special interests. The plans on building large scale hydro power plants are reflected in every policy documents of energy sector. The decision on the required investment had been made and projects had been discussed few times in parliament and cabinet meetings. Even so, it still didn’t move forward due to political reasons. For HPPs, politics is the main barrier.

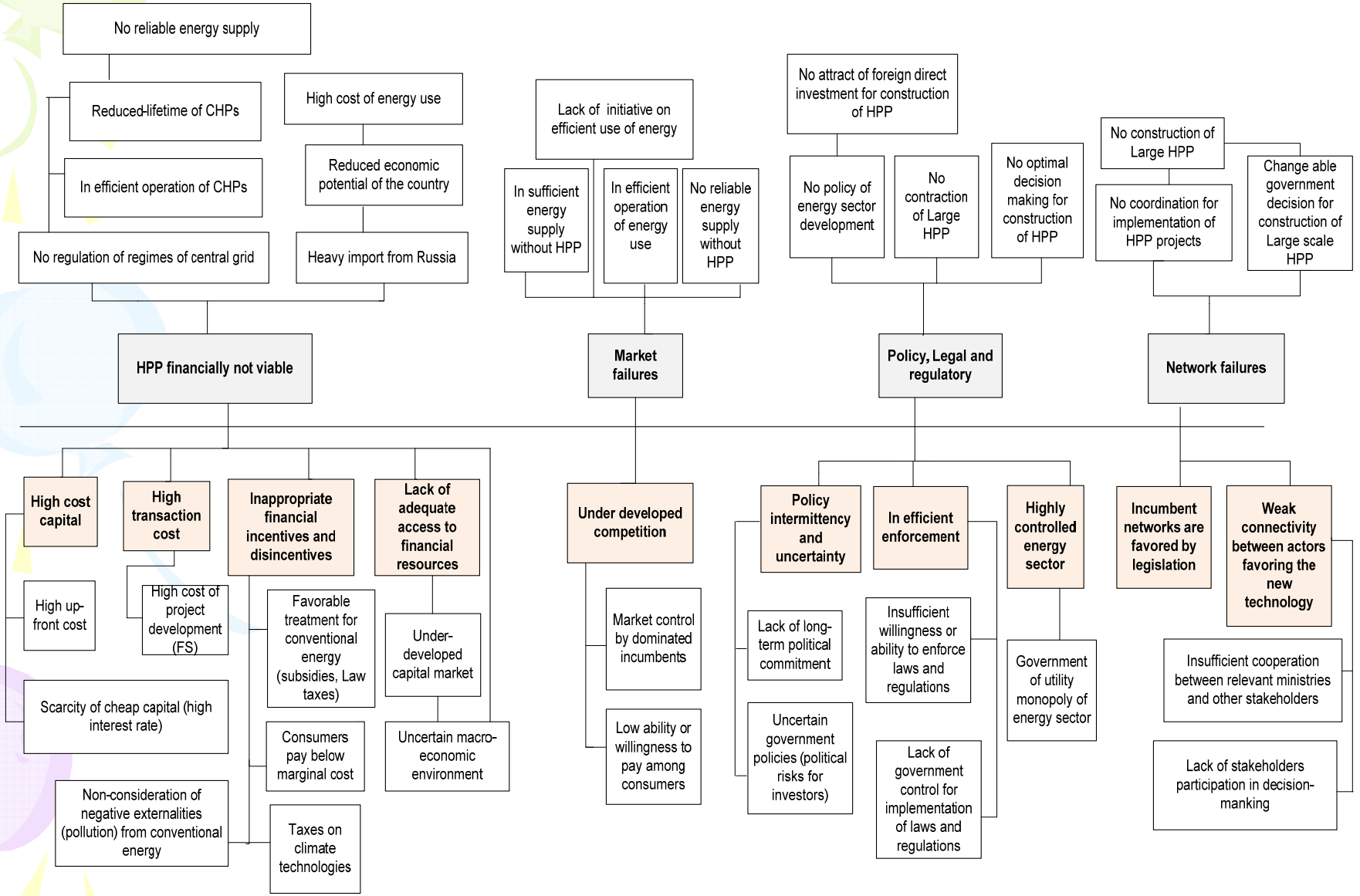
TNA – Barrier analysis

Specific barriers for HPP, WP

- Regarding the wind park the highest priority is a system constraints or Capacity limitation with grid system.
- Wind parks affect the energy system stability as it operates in an uncontrolled manner when there is wind. Especially for countries like Mongolia where energy system consists of small sized coal fired power plants, connecting many high capacity wind power plants will destabilize the system.
- On the other hand, there are many companies who are interested in developing wind parks because the renewable energy law has explicitly stated the feed in tariff to be provided for electricity supplied by wind. As of 2012, there are 5 companies who obtained special license to construct wind parks and the planned installed capacity of all these wind parks are 500 MW.
- The main difficulties encountering implementation of large Hydro power plant projects is low electricity tariff. Even though in the renewable energy law, it is mentioned that feed in tariff to be provided for electricity supplied by renewable energy resources, the electricity generated by HPPs with capacity more than 5MW is not covered under this feed in tariff. This low tariff hinders investment in hydro power plant project as the power purchase agreement doesn't reflect feed in tariff mentioned in the renewable energy law.

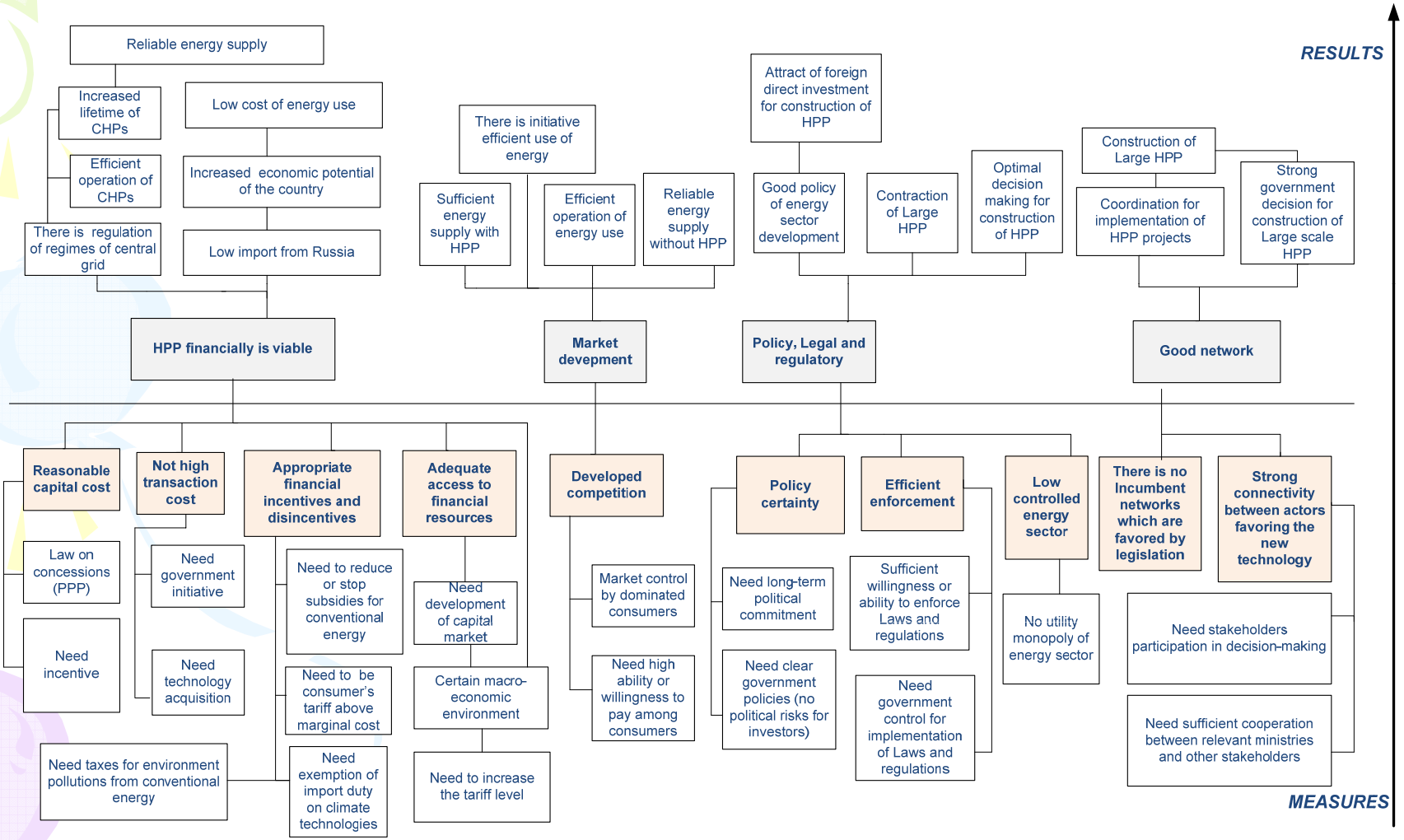
TNA – Barrier analysis

Problem tree and causal relation for the HPP



TNA – Barrier analysis

Translated problem to solutions for the HPP



Barrier analysis

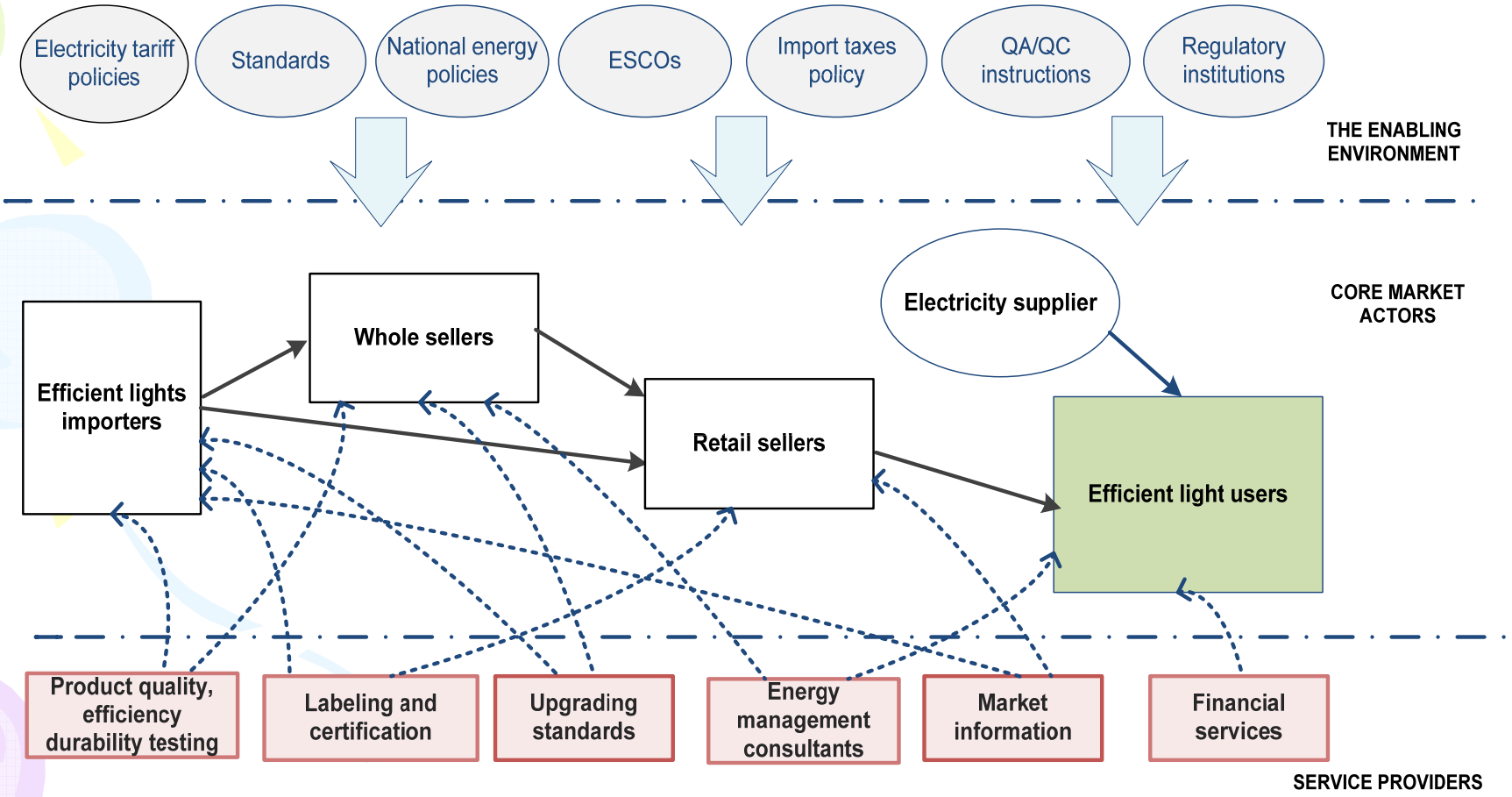
Identification of barriers for efficient lighting technology

	Barriers	*Average Scores*	*Rank*
	Economic and financial		
1	Lack of adequate access to financial resources	2.6	3
2	High cost of capital	3.4	2
3	Inappropriate financial incentives	3.0	1
4	Uncertain macro-economic environment	2.4	4

	Barriers	*Average Scores*	*Rank*
	Market failure		
1	Poor market infrastructure	2.8	6
2	Underdeveloped competition	3.1	5
3	Market size	2.6	7
	Policy, legal and regulatory		
4	Insufficient legal and regulatory framework	4.3	1
	Institutional and organizational capacity		
5	Lack of specialized ESCOs	3.4	4
	Human skills		
6	Inadequate personnel for preparing projects	2.3	8
	Information and awareness		
7	Lack of awareness about climate technologies	3.8	2
	Technical		
8	Product not reliable	3.7	3

TNA – Barrier analysis

Market mapping for efficient lighting technology



TNA – Barrier analysis

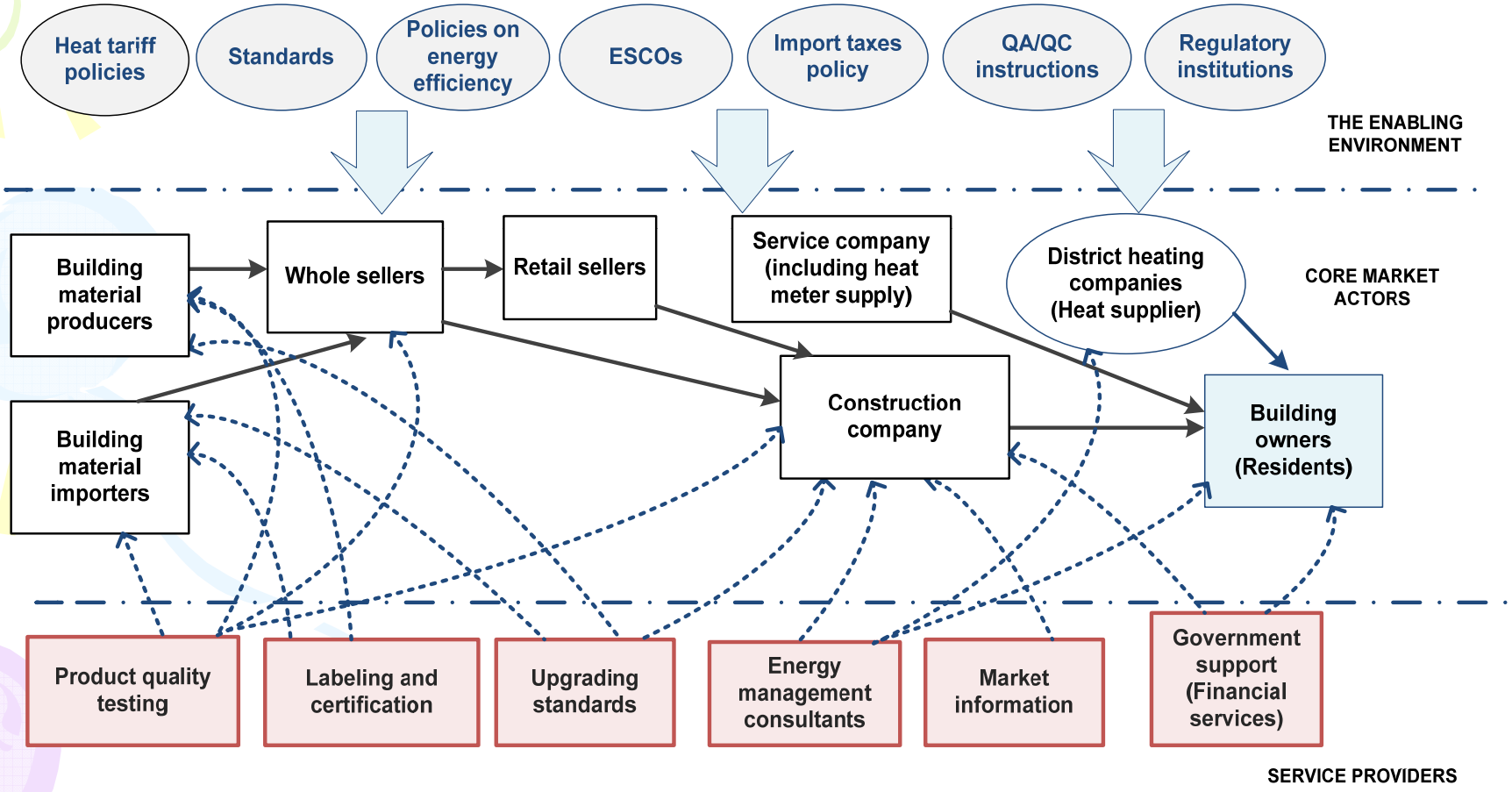
Identification of barriers for the technology - Improved insulation of panel apartment buildings

	Barriers	Average Scores	Rank
	Economic and financial		
1	Lack of adequate access to financial resources	3.8	2
2	High cost of capital	3.7	3
3	Inappropriate financial incentives	4	1
4	Uncertain macro-economic environment	2.6	4

	Barriers	Average Scores	Rank
	Market failure		
1	Poor market infrastructure	3.8	1
2	Underdeveloped competition	3.6	3
3	Market size	2.7	7
	Policy, legal and regulatory		
4	Insufficient legal and regulatory framework	3.6	2
	Institutional and organizational capacity		
5	Lack of professional institutions	3.5	4
	Human skills		
6	Inadequate personnel for preparing projects	2.6	8
	Information and awareness		
7	Lack of awareness about the technology	3.5	5
	Technical		
8	Quality of technology	3.2	6

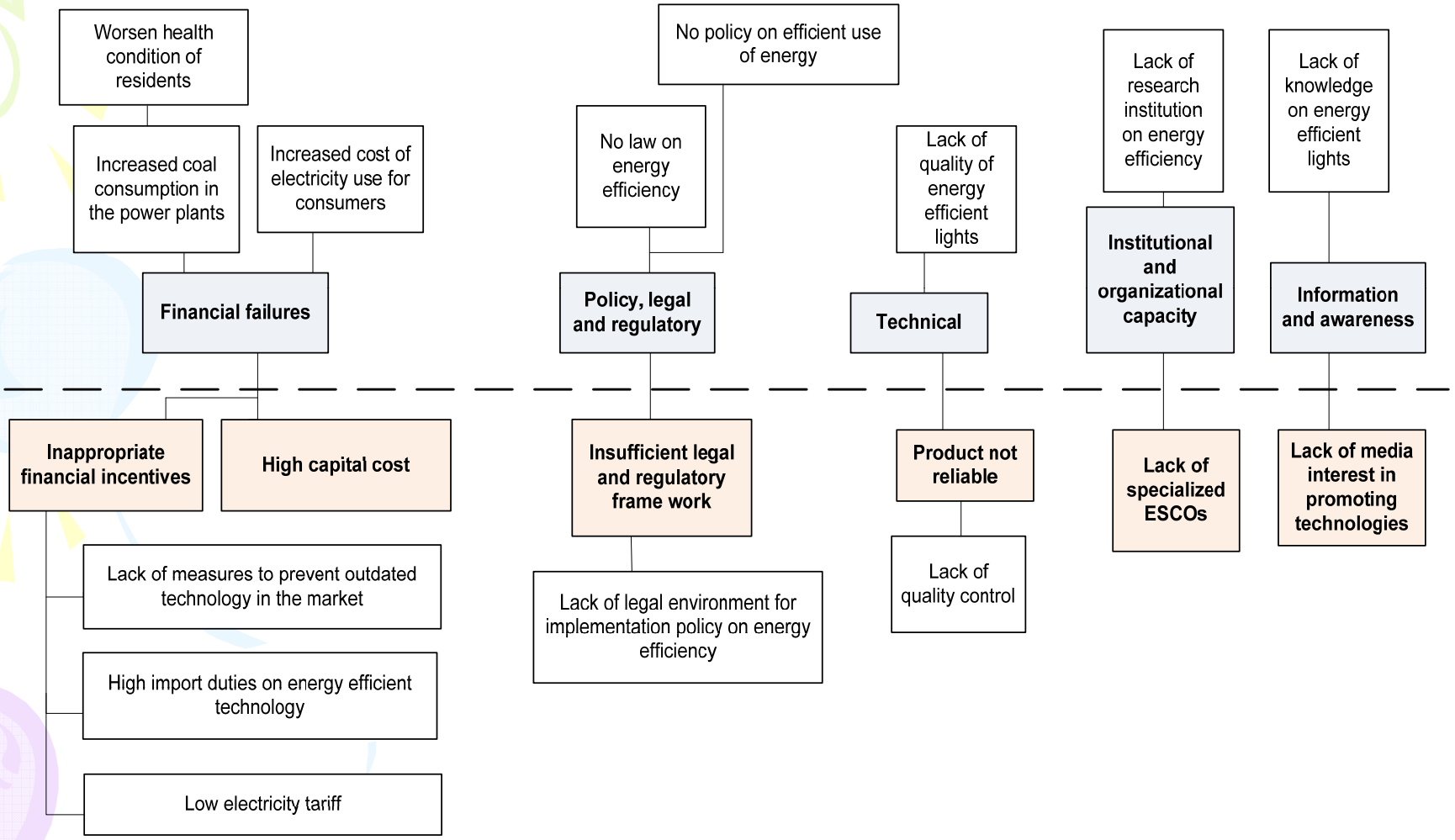
TNA – Barrier analysis

Market mapping for Improved insulation of panel apartment buildings



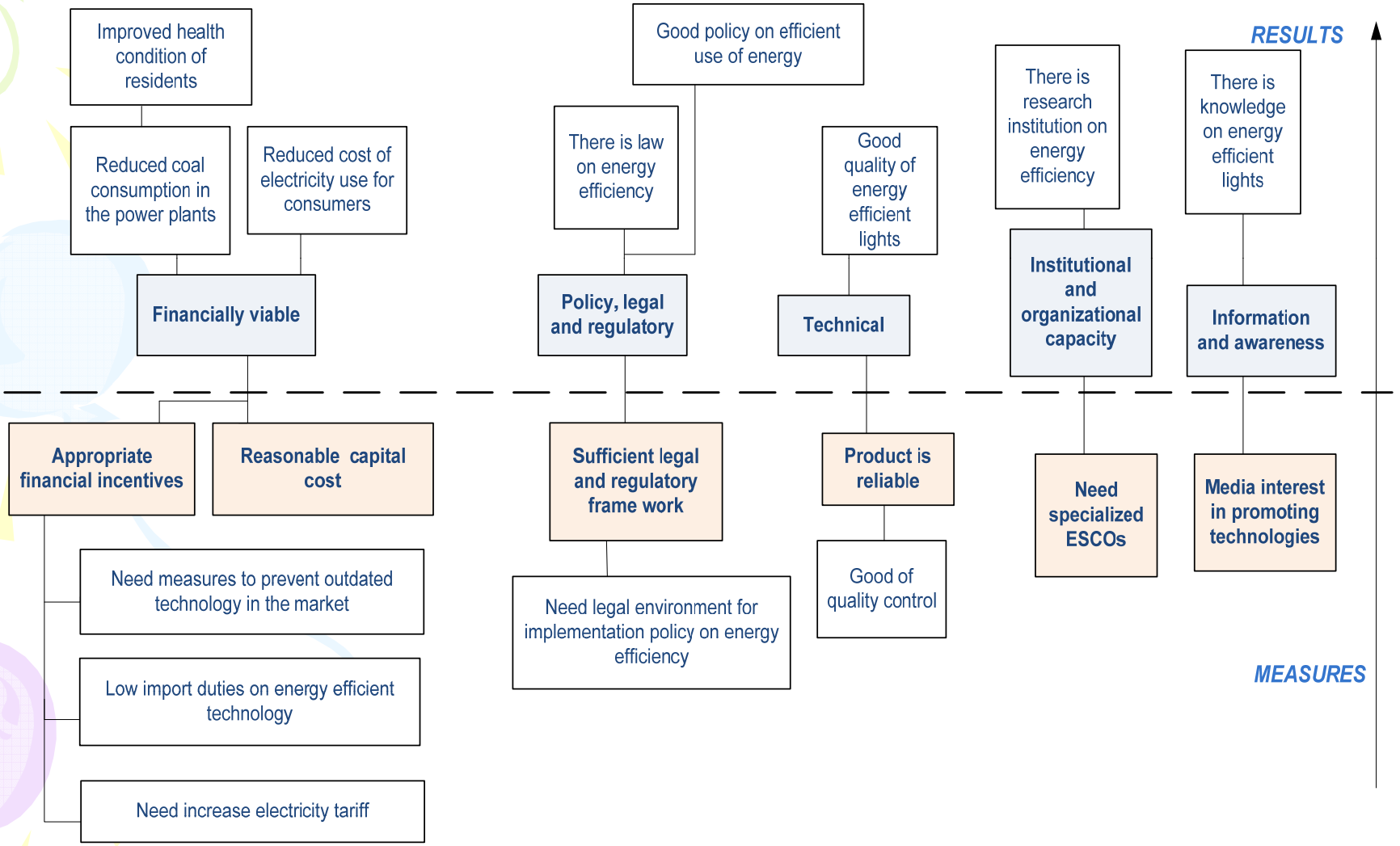
TNA – Barrier analysis

Problem tree and causal relation for Improved insulation of panel apartment buildings



TNA – Barrier analysis

Translated problem to solutions for Improved insulation of panel apartment buildings



TNA – Barrier analysis

Common barriers for Improved insulation of panel apartment buildings

Barriers faced by efficient lighting and building insulation technologies in the residential and commercial sector appear to be quite similar.

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- The common economic and financial barriers are inappropriate financial incentives, lack of adequate access to financial resources and uncertain macro-economic environment.
- Common barriers regarding the policy, legal and regulatory aspects are mismanaged energy sector; lack of laws and regulations on energy efficiency.
- Common barriers regarding the market and network aspects are insufficient coordination between relevant ministries and other stakeholders, lack of professional institutions; and lack of confidence in new climate technologies

The priorities of barriers are different for the two specific technologies.

- For the efficient lighting technology, the most important barriers are low electricity tariff and lack of management for implementation of the technology
- For the building insulation technology, the barriers of highest priority are high cost of capital and law constant tariff not depending on actual heat consumption.

Technology Action Plan -TPP

Measures	Actions	Why need to take these actions?	Responsible organization	Time frame	Expected budget, 1000USD	How can be fund
Policy, legal and regulatory						
Long term political commitment .	Development and approval of long-term program for the development of energy sector of Mongolia	In the nearest future, electricity demand increases. To cover he needs of 85 percent of this demand electricity, it is necessary to build large scale TTP near local coal deposits. This should be included in the program	Ministry of Environment and Green Development; Ministry of Energy; Ministry of Economic Development	1 year	150.0	State budget
	Follow instructions on enhancing TPP in the National climate change program	Currently, a master plan for energy sector development of Mongolia is the major policy document. Some revisions is essential	Ministry of Energy; Ministry of Economic Development	0.5 year	100.0	State budget
	For the energy sector is necessary to develop a special program for the introduction of new technology and more efficient energy production	These provisions are embedded in the national program of climate change and document the development of green economy within the country. Therefore, they should be used	Ministry of Environment and Green Development; Ministry of Energy;	1 year	120.0	State budget

Technology Action Plan -TPP

Economic and financial measures						
improve the financial capacity of the country	Create a financial fund for capital building area of major strategic targets	The country's export has been increased with intensive development of the mining sector in last few years. At the same time, the political parties distribute cash to the population so they can fulfill election campaign promises. This cash distribution activity shall be stopped and instead a fund to develop the country shall be established to allocate such fund.	Government, Parliament	1 year	No need	-
	Obtaining of a loan or bond	In near future, over USD 1.8 billion will be required to construct large-scale, high-efficiency TPPs. In order to raise the capital, attracting foreign investment or applying for international soft loans are essential for implementing the TPP projects.	Ministry of Economic Development; Ministry of Finance	1 year	No need	-

Technology Action Plan -TPP

Market						
Create and develop a system that increases the responsibility of employees to improve the efficiency of energy production	development and adoption the law on energy saving	establish a working group to develop the law of energy conservation	Energy Regulatory Committee of Mongolia	1.5 year	100.0	State budget
Create a market price system for the energy sector	development and approval of guidelines of the energy price	establish a working group to develop guidelines on energy pricing /tariffing system	Government of Mongolia, Energy Regulatory Committee of Mongolia		No need	--
Prepare skilled local experts who could develop project development study including Feasibility Studies	training of specialists in developed countries	Large and modern thermal power stations working on this technology for Mongolia completely new. Therefore, the development of the project should be made highly knowledgeable	Ministry of Education and Science; Ministry of Energy;	3 year	5000.0	State budget
preparation of specialists on thermal power plants operate at super critical pressure of steam	retraining of teachers in developed countries	currently prepares an engineer TPP The Institute can graduate engineers for the new technology	Ministry of Education and Science; Ministry of Energy;	5 year	10000.0	State budget

Technology Action Plan -TPP

Network						
improving the performance of any real decisions and programs on energy development	Establishing the principle of solutions of global importance necessarily based on the recommendation and findings of leading scientists and specialists	creating energy research institute under the Ministry of Energy. Initiators of this project - the ministries and authorized agents – do not support involvements and requests of scientists, local authorities and community in the decision-making and this results in later on unexpected barriers during the implementation, in some cases even lead to cancelling the project implementation.	Government of Mongolia, Ministry of energy	1 year	10000.0	State budget
establishment of the principle of "in the Ministry work only highly qualified employees of the industry"	continuous training of workers. To support employment of experienced engineers and scientists at the Ministry of Energy. To prioritize improvement of their professional skills and sustainable employment with staff development programs and benefits and at the same time to increase responsibility mechanisms to higher level	Administration of the Ministry of Energy is unsustainable; each time after the political elections, non-professional and political activists are appointed to major positions and whom in turn build own team consisted of non-professionals with less experiences. This inappropriate phenomenon is very common.	Government of Mongolia. Parliament	yearly	1000.0	State budget

Thank you for attention