

Clean Heat in the MENA Region

Status Report



| Friedrich-Ebert Stiftung

| Carbon Free Industry UG

| January 2020

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CARBON FREE INDUSTRY
finance & consulting

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The Regional Energy and Climate of Project in the Middle East and North Africa (MENA) of Friedrich-Ebert-Stiftung has commissioned, edited, reviewed, and published this study.

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About FES Regional Climate & Energy Project MENA

The Regional Climate and Energy Project MENA advocates for an energy transition into renewable energy and energy efficiency. It continues to search for solutions for a just transition in the energy sector ensuring both, the protection of the planet and the people.

As the MENA region is one of the most affected areas by climate change, we contribute to policy advising, research, and advocacy in the areas of climate change policy, energy transition, and urban sustainability, with the support of research institutions, civil society organizations, and other partners in the region and in Europe.



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3.0: LIST OF ACRONYMS

Acronym	Description
ANME	Agence Nationale pour la Maitrise de l'Energie
BDL	Banque Du Liban
DH	District Heating
EBRD	European Bank for Reconstruction and Development
EE	Energy Efficiency
ESCO	Energy Service Company
FNME	Fonds National de Maîtrise de l'Energie
HVAC	Heating, Ventilation, and Air Conditioning
LCEC	Libanese Center for Energy Conservation
LPG	Liquified Petroleum Gas
M&V	Measurement and Verification
MENA	Middle East and North Africa
MEPS	Minimum Energy Performance Standards
Mtoe	Million Tonnes of Oil Equivalent
MW	Megawatt
NEEAP	National Energy Efficiency Action Plans
NREAP	National Renewable Energy Action Plans
PBI	Performance Based Incentives
PROSOL	Programme Solaire
RE	Renewable Energy
RE-E	Renewable Energy - Electricity
RE-H	Renewable Energy - Heating
RHI	Renewable Heat Incentive
SEFF	Sustainable Energy Financing Facilities
STEG	Société Tunisienne d'Electricité et de Gaz
SWH	Solar Water Heating
TFEC	Total Final Energy Consumption
UAE	United Arab Emirates
UNEP	United Nations Environment Programm

4.0: INTRODUCTION

CLEAN HEAT IN THE MENA REGION

Even though heating is responsible for a major part of the world energy consumption, and by extension CO2 emissions, it lags behind in adapting clean energy. It is also insufficiently addressed by governments. While 126 countries have regulations for renewable power, only 21 countries have regulations for heating derived from renewable energy (RE-H) and cooling (see Figure 1) (IRENA, IEA and REN21, 2018).

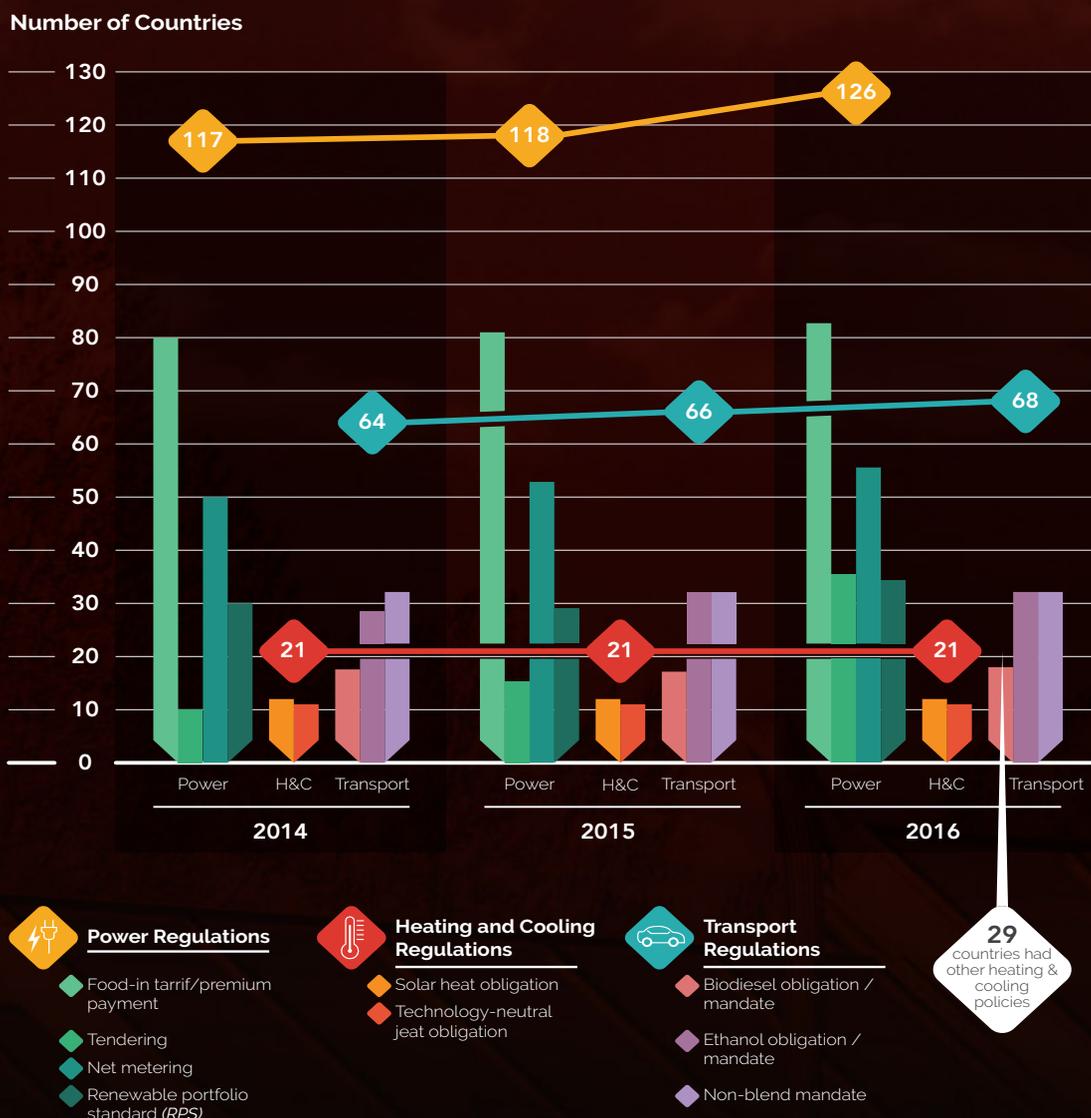


Figure 1: Renewable energy regulations by sector (IRENA, IEA and REN21, 2018)

Despite comparatively high temperatures in the MENA (Middle East and North Africa) region, there is a substantial demand for heat. While this holds particularly true for industry and commerce in several areas, the residential sector commands significant demand for heat. Although the heat sub-sector does not receive sufficient attention overall, the region has numerous success stories for both technology and policy. This report provides a current overview on the situation of clean heat in the MENA region. First, heat demand and supply will be characterized (see chapter 2) and technologies for RE-H described (see chapter 3). The major barriers to RE-H will be identified (see chapter 4) and policy options outlined (see chapter 5). Afterwards the status of RE-H in the MENA region will be assessed and best practices from both policy and technology presented (see chapter 6).

While it cannot examine the situation comprehensively, this report rather prepares the ground for more detailed work.

Background Image:

*Solar thermal collector system at the Princess Noura University in Riyadh (Saudi Arabia)
Picture from AEE Intec, Gleisdorf (Austria)*

5.0: DEMAND AND SUPPLY OF HEAT

The total final world energy demand in 2016 reached 9,555 Mtoe (Million Tonnes of Oil Equivalent) (IEA, 2018), whereas heating accounted for around 50% of that consumption, as shown in figure 2 (Collier, 2018), and for around 40% of total CO2 emissions.

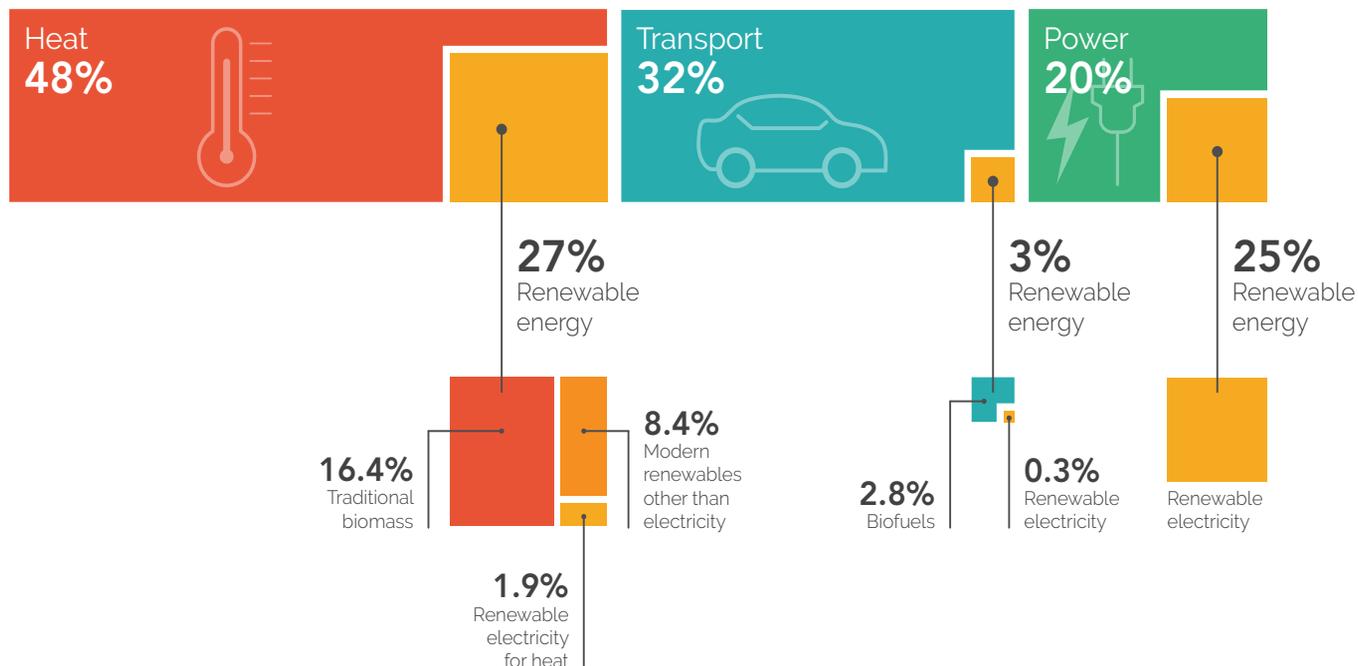
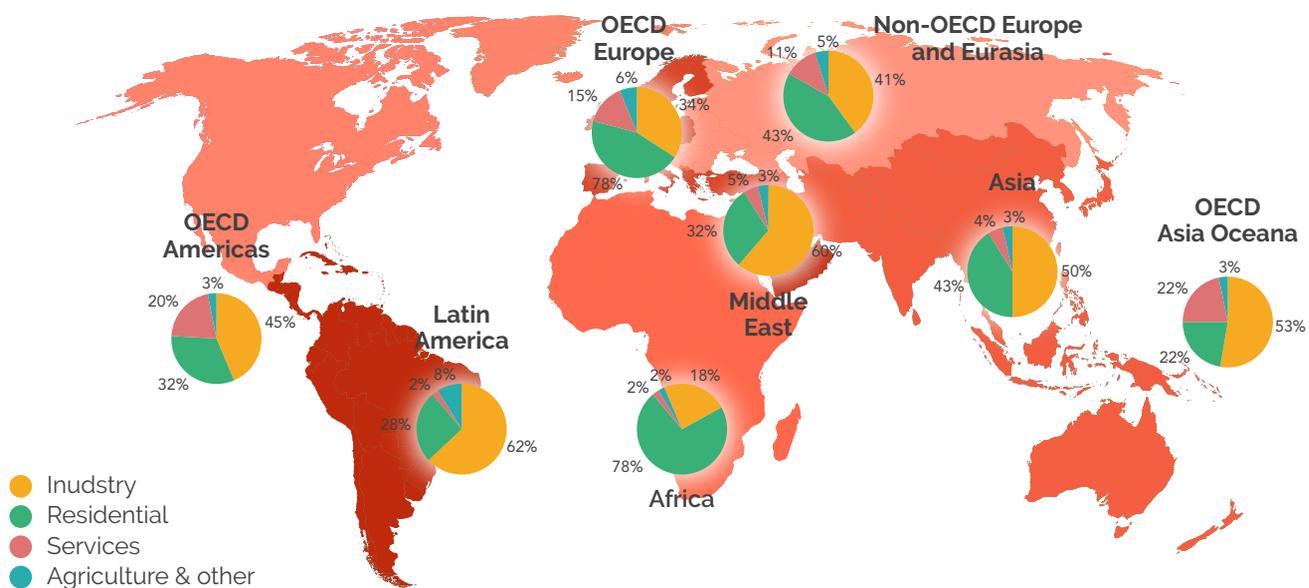


Figure 2: Renewable energy in total final energy consumption, by sector, 2015 (REN21, 2018)

The largest demand for heat comes from the residential sector, followed closely by industry. The regional contribution to heat consumption by sector is shown in Figure 3. The variations reflect primarily the local climate and the level of industrialization.



This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

Figure 3: Heat consumption by region and sector (IEA, 2012)

5.1 Demand for Heat

When addressing heat, it is important to consider three dimensions of the demand for heat. They are relevant to accurately describe the demand by the residential, industrial, and commercial sectors.

- **Spatiality** – Where is the specific demand? This is important because heat cannot be easily transported. For residential heating in particular, the location determines the total demand.
- **Seasonality** – How does the demand vary over the year?
- **Temperature** – What temperatures are required (ranging from temperatures below 50°C for residential heating to > 1,000°C for some industrial processes)?

In the following paragraphs, conceptual demand profiles for all three sectors (residential, industrial, commercial) in multiple locations in the MENA region will be provided and described – with respect to the seasonal and temperature dimensions mentioned above.

5.1.1 Residential Heating Demand:

The largest heat demand in buildings comes by far from space heating, while there is further demand for domestic hot water. Even though, less heating is required in MENA compared to other regions, the sector is still important. The demand for heat is driven by the need to stay warm during the cold temperatures of the winter season and by the fast growth in the total build area due to the large and ongoing increase in population. As shown in Figure 4, exemplary heat demand profiles in two locations in the MENA region are shown: Baalbek in Lebanon and Riyadh in Saudi Arabia. The figure points out that the space heating load, as a percentage of peak load, is highest in the coldest months of the winter but drops down to 0 in the summer. Even though the required temperature for space heating is only around 40°C, it is often supplied at higher temperatures, which results in lower efficiencies for most heating technologies.

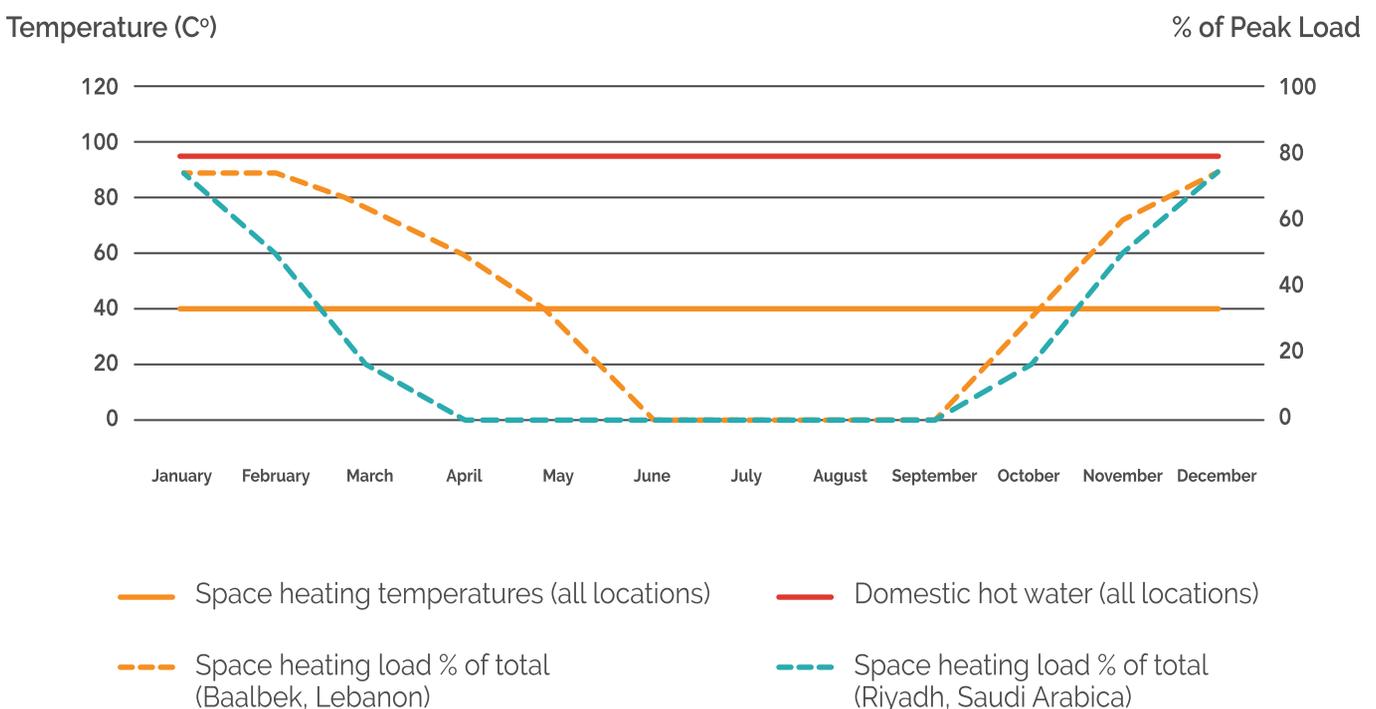
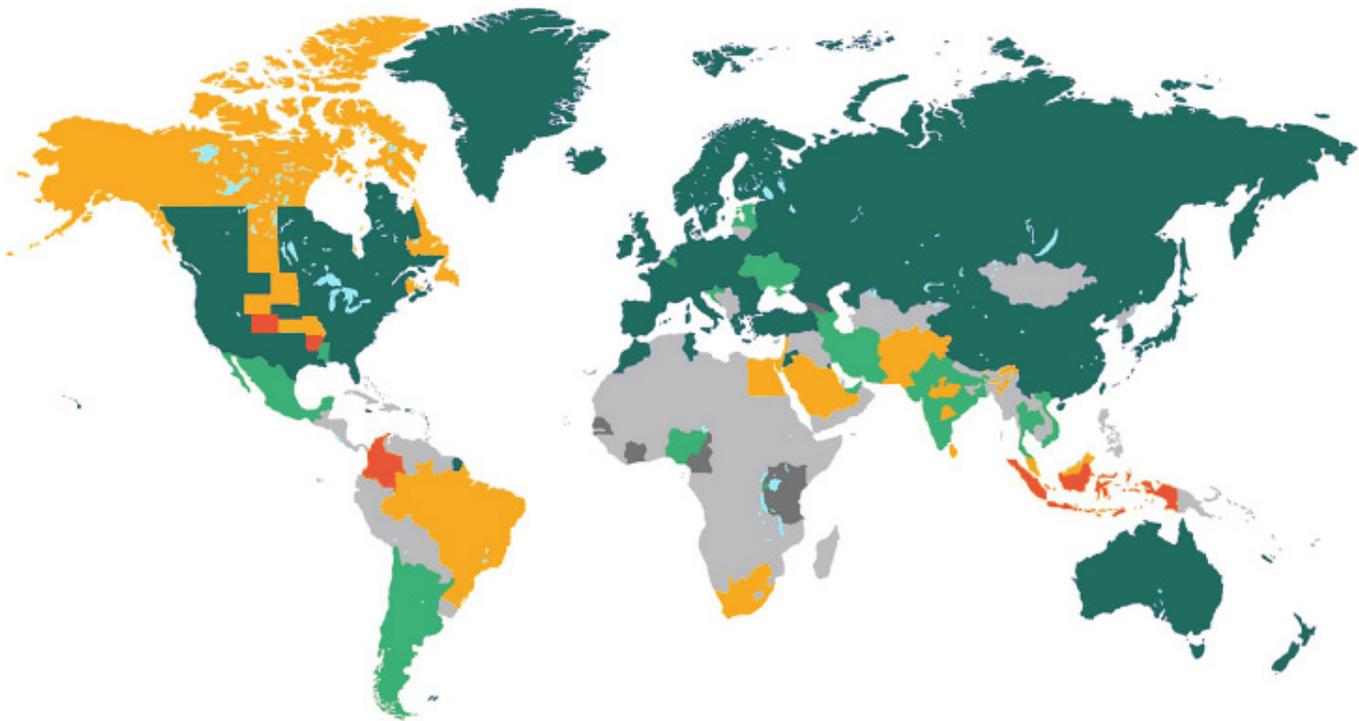


Figure 4: Two exemplary heat demands of residential buildings in the MENA region (authors of this study)

Energy efficiency needs to be improved first before renewable heat is addressed, particularly in buildings. The adoption of building codes is the most common approach for improving efficiency, as will be discussed in chapter 5.2. As the map in Figure 5 indicates, several MENA countries still lack building codes, while “enforcement seems to be the core challenge in the region” (Visser, 2013).



- Mandatory for entire sector
- Voluntary for part of sector
- Mandatory for part of sector
- Code in development
- Mandatory for part of sector in major city
- No known code

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

Figure 5: Building energy codes by country, state and province 2016 (Abergel, 2017)

5.1.2 Industrial Heating Demand:

Aided by the fact that space heating is of less importance in the MENA region due to its temperate weather, the industrial sector accounts for more than 50% of the total heat demand. Figure 6 shows exemplary heat demand profiles for selected industries. Despite the simplification, there are two major findings: The industrial heat demand hardly fluctuates seasonally and different processing temperatures are required for different processes.¹

¹ In fact, within each industry there are commonly several processes taking place at different temperatures yet this was not considered in the chart.

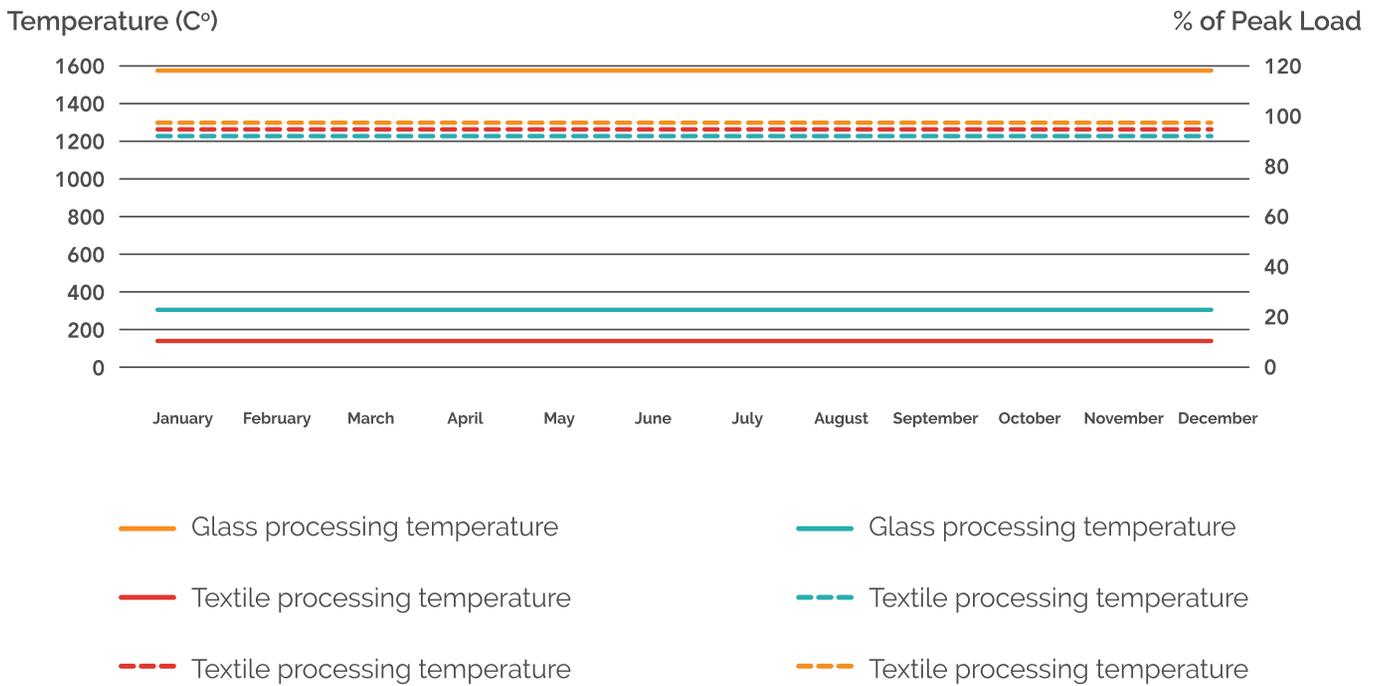


Figure 6: Exemplary heat demand of selected industries (authors of this study)

5.1.3 Commercial Heating Demand:

Within the context of this study the commercial sector comprises diverse applications, not addressed by the residential building or industrial sectors, such as services, shopping centers, canteens, hotels, and hospitals. While all of them also have demand for space heating, they also have further heating demand for their activities. The chart in Figure 7 shows an example of the heat demand in a hospital in the MENA region. In this case, the hospital in Amman requires also a substantial heating load in the winter months, as a percentage of peak load. As the Figure shows, there are different kinds of heat demand (space heating, laundry, sanitary, and kitchen), each of which has a unique temperature profile and heat load over the year. Space heating is the largest single load but occurs only in winter.

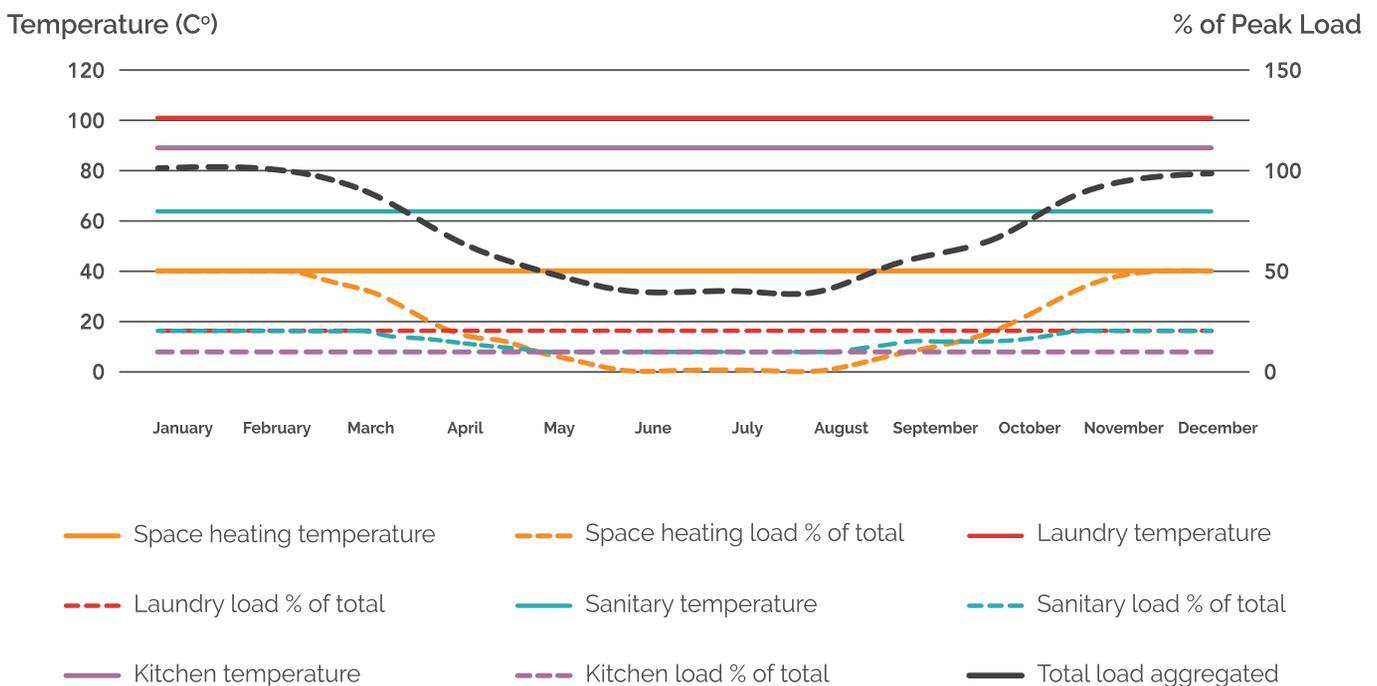


Figure 7: Exemplary heat demand of a hospital in the MENA region (authors of this study)

5.2 Supply of Heat

Today around 72% of all heat is supplied by the combustion of fossil fuels. As a result, heat accounts for around 39% of CO₂ emissions associated with energy production (IRENA, IEA and REN21, 2018). The tiny share of heat supplied by renewable energy consists mainly of traditional use of biomass for heating purposes. Although it is increasingly being applied, RE-H grew by only 12% between 2010 and 2015 compared with 31% growth of RE-E (Renewable Energy – Electricity) (Collier, 2018). Thus, RE-H is currently not on track to meet the 2°C target of the Paris Agreement. RE-H needs to grow by 32% between 2014 and 2025 in order to achieve the goal set by the Paris Agreement (IEA, Tracking Clean Energy Progress 2017, 2017).

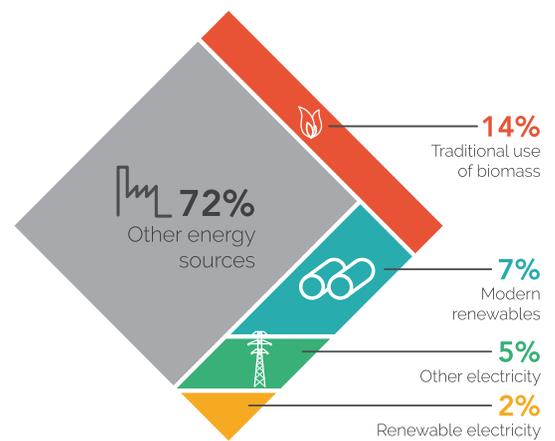


Figure 8: Source of heat supply (IRENA, IEA and REN21, 2018)

Renewable Heat Consumption by Source

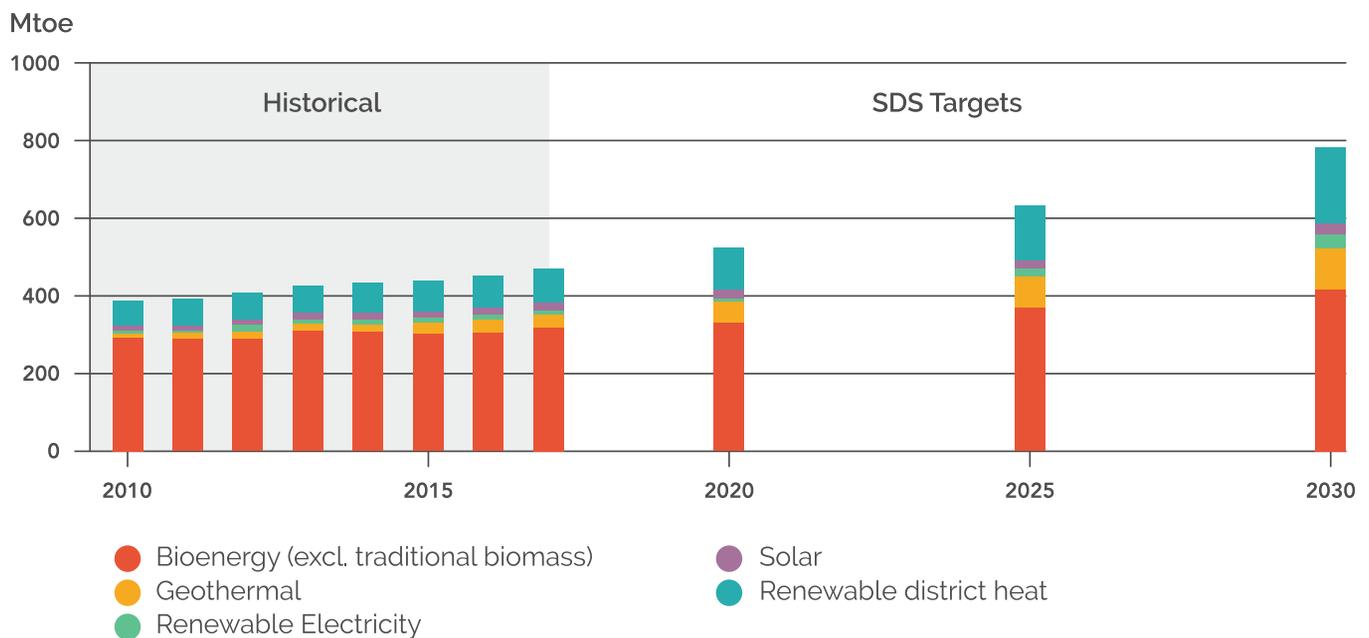


Figure 9: Renewable heating by source (IEA, 2018)

Hence, various scenarios for the future of heat supply are currently being discussed (e.g. in (Collier, 2018) or (IEA, 2018)). All foresee that by 2040, a major share of heat will still be supplied by fossil fuels. There are two major uncertainties affecting the long term predictions of heat supply. One is the role of sector coupling, which refers to the extent by which electricity generated by renewable energy can be used to supply heat. The other uncertainty concerns the role of renewable fuels (e.g. power-to-gas), which can later be used for heating. Unfortunately, sector specific data on the use of RE-H is not available.

Since heat is primarily supplied by fossil fuels, the adverse effects of fuel combustion on human health and the environment are also important aspects. Unlike CO₂, air pollution emissions have significant impacts locally. In the past few years, air pollution has become a major area of concern, not only in Europe where primarily cars are considered polluting, but also in emerging markets such as China. Addressing fuel-based heat supply in cities can be a very effective mean to lower pollutants.

5.3 The Market for Heat

As the markets for heat and electricity differ, there are also differences with respect to the opportunities for market interventions, which will be discussed later. A thorough appreciation of the differences between heat and electricity markets is necessary to understand the current status of the heat market and to tailor interventions effectively. Most importantly, heat is not provided by a centralized provider through a centralized grid but generated on site.² This leads to the following effects:

5.3.1 Challenges of Interventions:

- **Data availability:** Compared to electric power, the quantity and quality of available data on heat demand is poor and the uncertainties with respect to sector attributions are greater. Additionally, the data available is less specific when it comes to spatial and temporal resolution. Therefore, planning is more difficult. The major underlying reasons for the poor availability of data are:
 - There is no consistent methodology for calculating sector contributions to heat generation on the macro level (houses can be heated with electric heaters; industry can burn fuel for process heating but also for onsite power generation, and liquid fuels can be either used for heating or for transportation) (Eisentraut A., 2014).
 - There is no centralized grid where the supply of heat could be monitored.
 - When supply data of fuels of combustion is considered, the data does not have a high temporal resolution (e.g. only fuel sales per month).
 - When supply data of combustion fuels is considered, the data does not have a temperature resolution (is it used for heating or domestic hot water? What is the desired processing temperature for a given industrial application?).
 - Data collection is more expensive for the distributed generation of heat.
 - Correlation between different geographic regions is difficult (especially relevant for the building segment).
- **Number of interventions** – Heat is commonly generated on-site by units with different owners. Accordingly, the transaction costs are higher in the heat market.
- **Local balancing between demand and supply** – Heat cannot be transported as easily as power. Even District Heating (DH) grids are marginal compared to the electricity grid. Accordingly, demand and supply have to be balanced on-site. Even though the cost of storing heat is lower than the cost of storing electric power, storage drives up the investment costs. Furthermore, often a conventional back-up needs to be available when the resource is not constantly available (e.g. solar thermal).
- **Uncertainty of cash-flows** – RE-H and RE-E differ with respect to the cash-flows of the asset owner. For RE-E in centralized grids the unit price is often known for the complete life-time (feed-in-tariff or power purchase agreement) or can be anticipated. The income from RE-H on the other hand is most often the savings on the fossil fuel bill. Depending on the pricing scheme, this can bring significantly higher fluctuations (see Figure 18) and uncertainty to investors – which increases the costs of finance.

² In northern countries cities sometimes use district heating. For the MENA region district cooling is relevant and already applied.

5.3.2 Opportunities for interventions:

At the same time there are also some opportunities which make RE-H interventions easier:

- **Less regulated market** – Heat is mostly generated on site through the combustion of fossil fuels. Unlike the distribution grid for electricity, there is no centralized grid for heat and therefore there are less regulations to adhere to, which reduces the administrative costs.
- **Local value creation** – All RE-H installations require substantial plumbing works. Thus, local value creation is automatically associated with the installation of any kind of RE-H technologies.

Key Takeaways – Demand and Supply of Heat:

- Heating accounts for almost 50% of total final energy consumption worldwide.
- Heat demand needs to be assessed by taking into consideration spatial, seasonal, and temperature dimensions.
- Heat demand by the three major sectors of residential, commercial, and industrial, differ significantly with respect to the above mentioned dimensions.
- Heat is still mainly supplied by the combustion of fossil fuels. Thus, the market for heat lags behind in the adoption of renewables.
- Heating market differs significantly from electricity market. The challenges for RE-H are insufficient data availability and higher number of required interventions.

The most common heat generation process is the combustion of fossil fuels in boilers, which vary in thermal capacity and temperature range. In addition, electricity is often used for heat supply. For example, in the residential sector, heat may be supplied by electric boilers to generate hot water. Heat may also be produced by split unit systems or electric radiators as part of the heating, ventilation, and air conditioning (HVAC) system. Some industrial processes, in plastic or aluminum manufacturing, require electric heating.

There is a broad variety of technologies for renewable heat generation, as depicted in Figure 10. These technologies possess different renewable energy resources (shown on the left hand side of Figure 10) and supply heat over a range of temperatures (shown on the right hand side of Figure 10). The major renewable sources of heat include biomass, geothermal energy, solar thermal power, heat pumps, electric heating with electricity generated from renewable sources, and waste heat recovery. In the future, opportunities exist for the production of heat by the combustion of fuels produced with electricity generated from renewable sources. In the MENA region biomass is less important because water resources are scarce, which limits the planting of energy crops and curbs the availability of biowaste. Nevertheless, biomass applications such as organic waste, which does not compete with food production, offer attractive options. The use of geothermal energy will be limited as well due to spatial constraints. Heat pumps or machines, which transfer heat by electric power from a heat source to a heat sink, increase the efficiency of electric heat generation since they can generate more heat per unit of electric energy applied, compared with direct electric heating. When there is demand for both heating and cooling, heat pumps use becomes even more efficient since they can provide heat and cold simultaneously. Therefore, heat pumps are expected to play an important role in the residential sector because they significantly increase the efficiency for electric heating and are especially climate friendly when driven by electricity generated from renewable sources. However, the utilization of heat pumps in industry is limited as their efficiency drops with increased output temperatures. In addition, the output temperature of heat pumps is ultimately limited to 150°C. Solar thermal heating is already widely applied in the MENA region by all sectors and is expected to play a crucial role in future heat supply. Nevertheless, with respect to the total potential in the MENA region, solar thermal heating is still in its infancy stage.

Ultimately, renewable fuels need to play a major role particularly in the industrial sector for processes in which current technologies cannot be applied to meet processing temperatures exceeding 400°C. Above all, in all sectors an increase in energy efficiency (EE) is of utmost importance to reduce the demand for heat in the first phase.

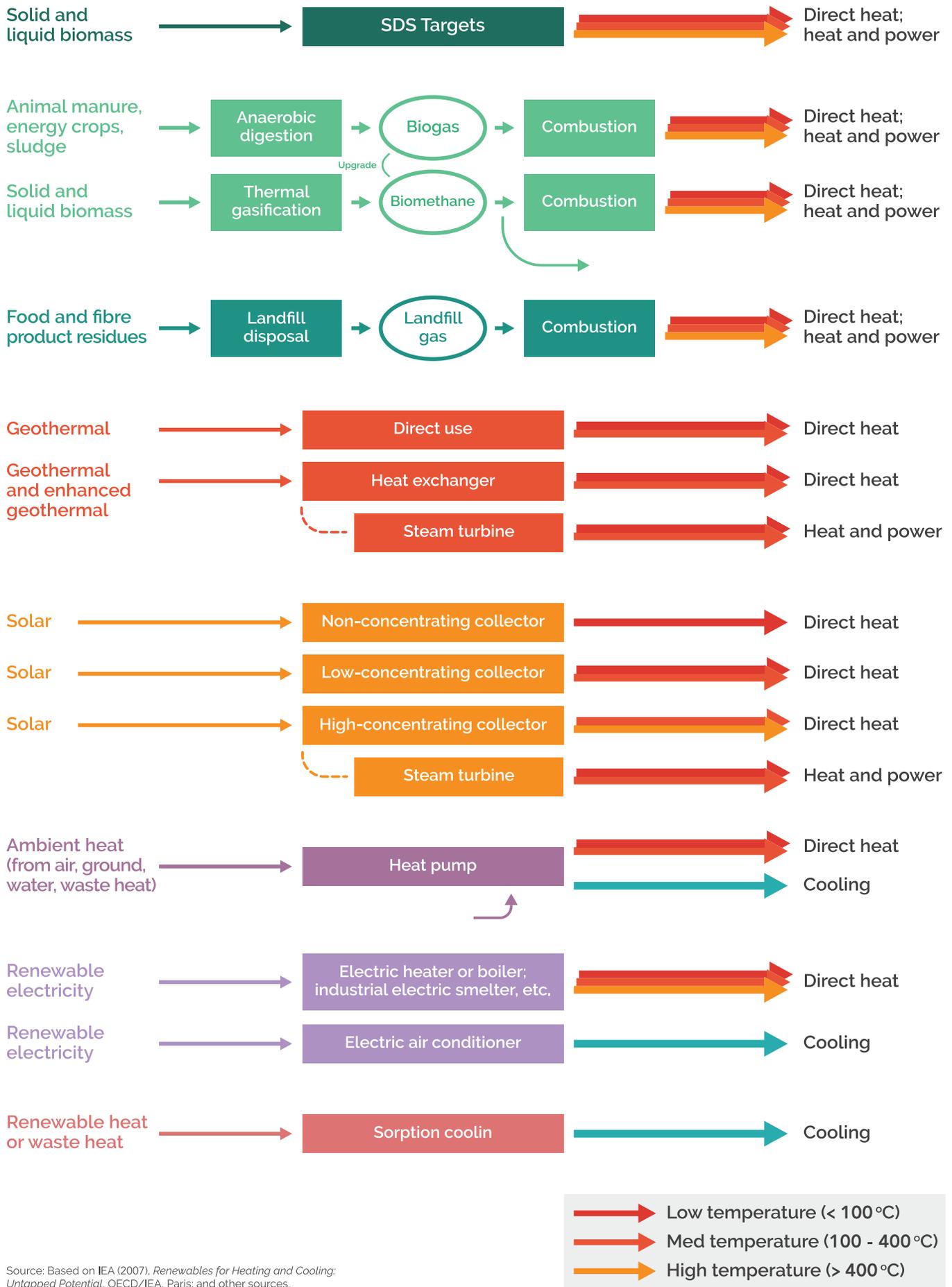


Figure 10: Resources and technologies for renewable heat (Eisentraut A., 2014)

As has been outlined above, heat differs in various dimensions. Thus, when identifying- suitable technologies to provide clean heat in the MENA region, several factors have to be considered:

- **Temperature** requirements for the specific technology.
- **Renewable resources** within the country (for most MENA countries biomass is relatively scarce while solar energy is abundant).
- **End users** – several technologies, such as geothermal energy, are not reasonable for small capacity applications.
- **Effects on electricity grids** - The effects of a RE-H source on the power grid within a country needs to be considered. Again, a careful assessment is required. Large numbers of electric heaters in winter times can be a challenge for grid stability. At the same time, electric generation of hot water in combination with hot water storage can, when flexibly controlled, be a good means to counter peak production.
- **Synergies with cooling** - For the MENA region, it is relevant to consider the demand for cooling. Technologies that can efficiently provide both can thus be particularly promising.
- **Socio-economic considerations** – energy policies need to be examined from a socio-economic perspective. In the MENA region job creation is especially important. One major positive side effect of the heat energy market is that the job creation per investment is high, and higher than most other renewables. Yet, this aspect needs to be further evaluated since it has not so far been quantified.

Key Takeaways – Conventional and Renewable Heating Technologies:

- Heating is still mainly provided through the combustion of fossil fuels.
- Numerous technologies for renewable heat are available.
- Identification of a suitable renewable heating technology depends not only on the type of renewable resources available, but also on the heat demand (spatial, seasonal, and temperature dimensions).

7.0: BARRIERS FOR RENEWABLE HEAT

RE-H faces numerous barriers which currently hamper its uptake. Whereas some of these challenges, such as high capital costs, also apply to RE-E, other challenges are unique for RE-H. Table 1 and Table 2 provide an overview of economic and non-economic challenges, respectively, based mainly on (Collier, 2018). The tables also offer policy solutions and examples where they have been applied – independent of a regional context but also relevant for the MENA region. In chapter 6 below, a specific MENA perspective is presented with regional policy examples provided.

Economic Barriers			
Barrier	Barrier Explanation	Policy Solutions	Policy Examples
Capital costs	Higher capital costs than fossil fuel alternatives. Access to affordable finance and capital for RE-H investments.	<ul style="list-style-type: none"> Investment support via grants and low interest loans. Heat generation-based subsidies to reduce payback periods and Energy Service Company approaches. 	<ul style="list-style-type: none"> France zero-interest loans. Green mortgage schemes. Germany market incentive programme and RHI (Renewable Heat Incentive) in the United Kingdom.
No level playing field with fossil heating fuels	Externalities such as carbon or air quality impacts not included for fossil heating fuels. Fossil fuel subsidisation.	<ul style="list-style-type: none"> Energy taxation and carbon pricing. Removal of fossil fuel subsidies. 	<ul style="list-style-type: none"> Carbon taxes in Nordic countries. Fossil fuel subsidy reform in countries such as India, Malaysia and Indonesia.
Current low and cyclical fossil fuel prices	Achieving running cost savings to pay back higher capital costs is more challenging. Reduced certainty over longterm competitiveness of renewable solutions versus fossil heating.	<ul style="list-style-type: none"> Adjustable energy/carbon taxes to provide price stability, "floor" price. Mechanisms to increase liquidity and tradability of biomass fuels. 	<ul style="list-style-type: none"> Currently not applied specifically to heat. Baltpool Exchange, Lithuania, ENplus certification, futures contracts for wood pellets.
Split incentives in the private rented sector	The building owner usually is required to invest in a RE-H system, but the occupier/tenant receives the benefit of running cost reductions.	<ul style="list-style-type: none"> Grants and ESCO approaches. Measures to pass the initial investment cost on to a third party, or obligations (e.g. improvement in energy performance). 	<ul style="list-style-type: none"> Green Deal scheme in the United Kingdom (now discontinued). Germany (Baden-Württemberg RE-H law).
Lack of economies of scale resulting in higher system costs	In the early stage of market growth, developing supply chains can lead to higher system costs. Lack of district heating infrastructure in many countries reduces costeffective opportunities to integrate RE-H.	<ul style="list-style-type: none"> Long-term policy support measures to allow supplier base and supply chains to grow. Incentives for local authorities, cities and industry to encourage investment in efficient district heating schemes with low-carbon supply. 	<ul style="list-style-type: none"> RHI in the United Kingdom. Heat Networks Delivery Unit funding in the United Kingdom. Fonds Chaleur in France.
High financing costs	Compared to RE-E the financial sector has less experience in financing RE-H project which results in higher financing costs	<ul style="list-style-type: none"> Dedicated credit lines for RE-H 	
High development costs	Compared to RE-E the development costs are often higher as less accurate data is available which increases either the risks or adds additional cost for data collection.	<ul style="list-style-type: none"> Support for project development 	<ul style="list-style-type: none"> Promasol scheme in Spain

Table 1: Economic barriers for renewable energy heating (Collier, 2018) and authors of this study

Non-Economic Barriers

<i>Barrier</i>	<i>Barrier Explanation</i>	<i>Policy Solutions</i>	<i>Policy Examples</i>
Building suitability	RE-H options may not be suitable in certain buildings (e.g. apartments). Low EE in building stock results in higher peak loads and increased capital costs, as well as reducing system efficiency in the case of heat pumps.	<ul style="list-style-type: none"> • Integrated EE and RE-H grant schemes. • Ensuring high efficiency through building codes. 	<ul style="list-style-type: none"> • Zero-interest loans for renovation in France and KfW programmes in Germany. • EU Energy Performance in Buildings Directive.
Industrial heat requirements	Can be challenging for some renewable technologies to fully meet the temperature, pressure and quantity of heat required by some industrial users. Sometimes restrictions on biomass use due to stringent emission requirements.	<ul style="list-style-type: none"> • Technology-related research, development and demonstration funding. • Carbon taxation on industrial emissions to encourage use where possible. 	<ul style="list-style-type: none"> • Within the EU H2020 scheme there are specific R&D calls for renewable heat. • EU ETS in the European Union.
Lack of awareness of and confidence in RE-H technologies	Can apply to households, heating system specifiers and lenders. Perception of renewable systems as inferior in terms of user comfort, exacerbated by failures of previous poorly designed/installed systems.	<ul style="list-style-type: none"> • Information programmes and advice provision (e.g. through energy agencies). • Equipment certification and standards as well as afterinstallation technical support services. 	<ul style="list-style-type: none"> • RHI roadshows in the United Kingdom. • Microgeneration Certification Scheme (MSC) in the United Kingdom.
Lack of supply chains & trained installers	Supply chains for fuels (e.g. biomass from agricultural residues) need to be established. Need for trained workforce to undertake design/specification, manufacturing, installation and O&M.	<ul style="list-style-type: none"> • Coordinated policies for agriculture, forestry and energy. • Training and certification programmes, better recognition of technology certification among countries. 	<ul style="list-style-type: none"> • Multiple. • Pan-European Heat Pump Keymark scheme. • SHAMCI scheme in MENA
Distressed purchase and consumer inertia	Solution needed at short notice when existing boiler breaks down, tends to favour replacement with the same (e.g. fossil fuel) technology.	<ul style="list-style-type: none"> • Renewable obligation for boiler replacement. 	<ul style="list-style-type: none"> • Germany (Baden-Württemberg RE-H law).
Disruption and "hassle" factors	Retrofit installation of RE-H systems may entail disruption (e.g. underfloor heating, biomass fuel storage). Renewable technologies also often require more space and can result in higher maintenance requirements.	<ul style="list-style-type: none"> • District heating to allow offsite deployment. • Installation of renewable systems during wider building renovation and regulations to ensure integration in new-build properties. 	<ul style="list-style-type: none"> • Municipality activities in Nordic countries. • Merton Rule policies for commercial buildings in the United Kingdom.
Lack of heat data and statistics	Needed to select favourable locations for installations and develop supply chains. Also relates to heat demand mapping for planning of district heating networks.	<ul style="list-style-type: none"> • Organisation and funding for heat mapping and zoning by local authorities. 	<ul style="list-style-type: none"> • Heat Networks Delivery Unit support in the United Kingdom, Denmark (zoning).

Table 2: Non-economic barriers for renewable energy heating (Collier, 2018) and authors of this study

Key Takeaways – Barriers for Renewable Heat

- There are numerous economic and non-economic barriers for RE-H.
- While many barriers for RE-H are identical to barriers for RE-E, there are also important heat specific barriers which need to be addressed explicitly.
- Most importantly, RE-H specific barriers are *i)* insufficient targets for RE-H and *ii)* insufficient data availability about the demand for heat.

8.0: POLICY OPTIONS TO FOSTER RENEWABLE HEAT

When discussing policy instruments for RE or EE, it is important to consider that different policies are required over the maturity pathway of specific technologies, whereas direct capital support decreases over time as technology costs drop. The International Energy Agency (IEA) has developed a general four-phase model for RE support policies, which is based on four phases: i) R&D, ii) Inception, iii) Mass deployment, and iv) Consolidation. The market deployment follows a S-curve, as can be seen in Figure 11 (IEA, 2008), (IEA, 2011). As described above, the heat energy market is more complex and less well understood than the electricity market, and therefore, it is more challenging to design effective policies (IRENA, IEA and REN21, 2018). To address this complexity, heat-specific policy principles were later added to the four-phase model (Milou Beerepoot, 2012).

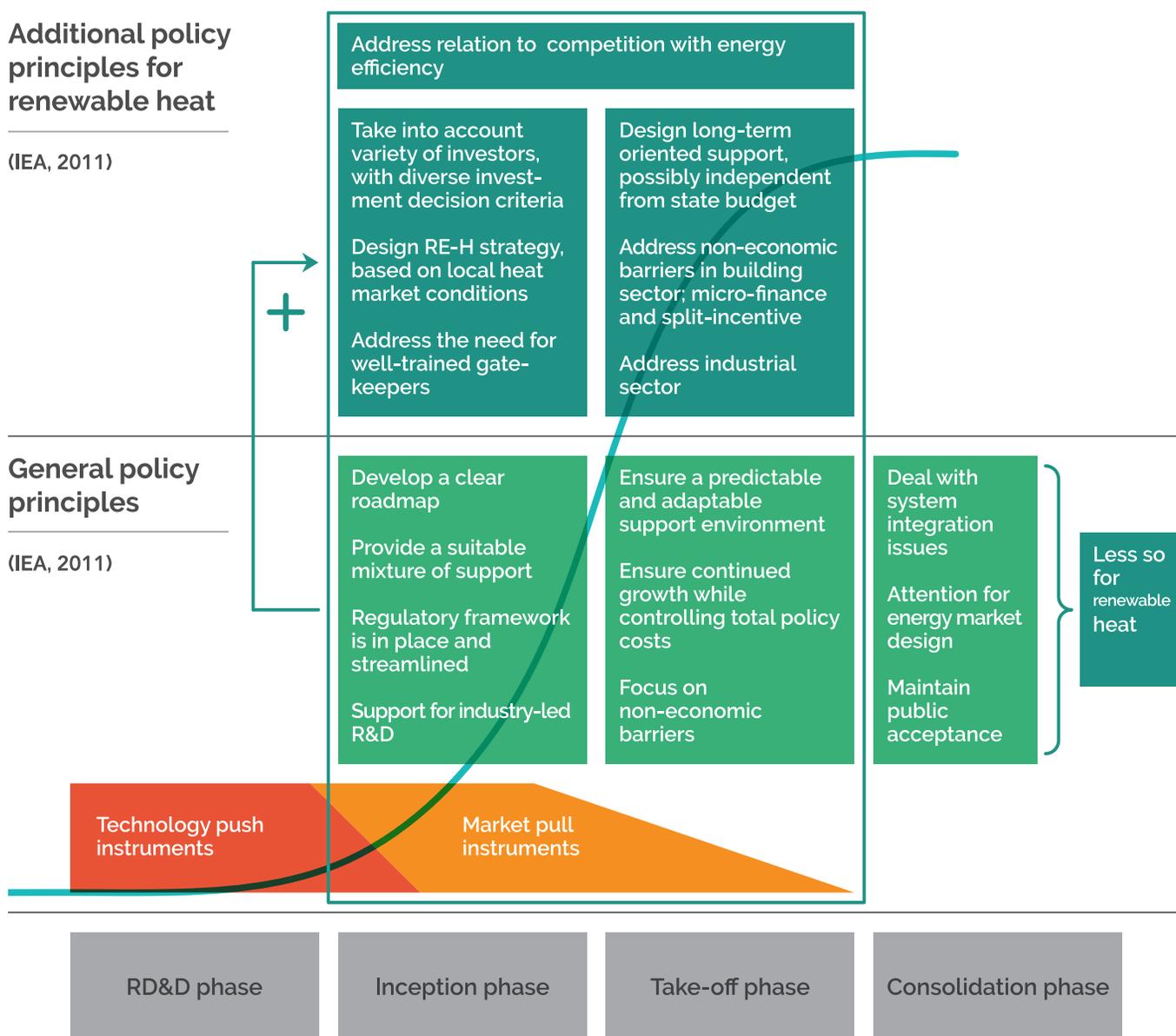


Figure 11: General and heat specific policy principles for renewable energies (Milou Beerepoot, 2012)

Policy options can be differentiated in 6 classes: i) plans and targets, ii) mandates, iii) upfront-incentives, iv) performance based incentives (PBI), v) soft-cost reductions, and vi) innovative financing, each of which is briefly described in the following sub-chapters (IEA-RETD, 2015). The various classes do not follow the market four-phase model described above, but rather considers the approach of the instrument, and can thus be implemented in parallel.

8.1 Plans and Targets

Plans and targets come at the very top level of policies. While plans and targets commonly require more concrete policy measures at a lower level to become effective, they are of utmost importance as they have a very strong effect on long term planning. Only with the conviction that there will be a sustainable market for RE-H, will the private sector invest and build up the capacity to address this market. Thus, plans and targets are especially important in the inception phase. Long term plans and targets can and need to be updated and fine tuned repeatedly. While 146 countries had sector specific targets for RE-E generation in 2018, only 48 countries had targets for RE-H and cooling (REN21, 2018). With respect to setting long term plans and targets, policy makers need to consider the following aspects (IEA-RETD, 2015):

- Mandatory or non-mandatory targets – Mandatory targets are commonly implemented through official legislation whereas non-mandatory targets are only stated in NREAP (National Renewable Energy Action Plans)³ or NEEAP (National Energy Efficiency Action Plans).
- Capacity or energy targets – Targets may refer to the capacity installed in MW or to the amount of energy produced in MWh.
- Static or dynamic targets – Static targets refer to a direct level to be achieved at a specific point in time whereas dynamic targets focus on annual growth rates.
- Sector coverage – The target may apply either to only one specific sector (e.g. residential), or may address the total heat demand.
- Technology coverage – Some countries set direct targets for a specific technology. The most prominent example worldwide, as well as in the MENA region, is solar water heating (SWH) targets.

8.2 Mandates

Mandates are legal obligations set by governments for the adoption of a certain share of a specific technology. Thus, RE-H mandates directly require utilities, district heating providers, or building owners to apply RE-H. Whereas utility mandates on renewable power in the electricity sector are quite common, mandates for RE-H are only found in the building sector. Mandates have major advantages. They overcome the hurdle that RE-H is often not considered by commercial building owners due to its complex hydraulics and need for well trained installers and operators. Secondly, they address the split incentive between building owners and tenants. Building owners have little incentive to invest in measures which reduce the energy costs for tenants as the former has to cover the energy costs, while the latter reaps the cost savings. At the same time, mandates can be linked to product standards and thus also ensure that certain minimum requirements are maintained. When designing building mandates for RE-H in the MENA region, the following aspects need to be considered (IEA-RETD, 2015):

- **Trigger** – What triggers the compliance? Most often mandates refer only to new buildings. However, they may also be linked to change in ownership or refurbishments.

³ Several MENA countries have NREAP or NEEAP

- **Sector** – Which sector is addressed by the mandates? The residential and/or commercial sectors are the targets mostly. Whereas the residential sector is larger, the commercial sector has substantially higher heating requirements per building. Therefore, the enforcement in the commercial sector is easier.
- **Capacity or Energy Mandates** – Like targets, mandates can refer to the capacity installed or the energy consumed. A reference to the consumed energy is reasonable for very large buildings in order to justify monitoring and verification.
- **Eligible Technologies** – Which technologies are eligible or mandatory? For the MENA region, SWH is the most prominent solution after thermal insulation.
- **Static or Dynamic Mandates** – When setting targets, a compromise has to be struck between what is technically and financially viable today and what is needed to achieve the CO₂ reduction targets. As technologies mature, costs come down and the limits of what is viable will also change. Thus, it is recommended to use mandates which tighten over time according to a transparent long term process (Bürger, 2011).

8.3 Upfront Incentives

Upfront incentives are direct capital supports to the investor which are paid during the investment and are thus not linked to the operation, and accordingly performance. They are one of the most suitable means to accelerate the uptake of a new technology as: i) they can have a significant impact on the end-users and ii) can target the key markets specifically (technology a in sector b satisfying criteria c). They are particularly suitable for thermal technologies where generation cannot be measured by a grid-operator. Direct incentives are especially used in early market phases since in more established markets the technology becomes more and more competitive – mainly due to economies of scale. However, upfront based incentives create a risk of non- or underperformance over the long-term (Barbose, 2006). An alternative approach is the adoption of performance-based incentives (PBIs), discussed in chapter 5.4. Even though PBIs are so far hardly applied for RE-H, it is expected that their importance will increase. The most important considerations for the design of upfront incentives for RE-H in the MENA region are (IEA-RETD, 2015):

- **Basis for incentive** – Upfront incentives can refer to various baselines, as mentioned below. Each baseline option sets slightly different incentives and comes with different administrative burdens. Thus, the optimal choice is context dependent.
 - A percentage of investment costs (e.g. x% of investment independent of the specific costs);
 - A percentage of system capacity (e.g. USD x /kW – whereas the relative support increases for lower priced suppliers); or
 - A flat baseline (e.g. USD x per SWH system (as is applied in Lebanon)).
- **Time of support** – Support can either be granted when the system is procured or after successful commissioning. The latter is more costly as it requires verification but can partly address the risk of underperformance.
- **End-user or supplier support** – Support can either be granted to the end-user or to the supplier. When the supplier is supported it is easier for the administration to address the risk of underperformance as poor performing suppliers can lose their eligibility.

- Cash or tax-credit support – While direct cash-supports constitutes an immediate burden on the public accounts, tax-credits are an attractive alternative. However, for industrial and commercial projects, the effects become more vague as they depend on the specific tax situation of an entity.

8.4 Performance Based Incentives

Unlike upfront incentives, performance-based incentives (PBIs) are not linked to the capital investment but to the performance over the complete lifetime of the plant. Even though PBIs overcome the risk of underperformance and are well established in the RE-E markets (e.g. feed-in-tariffs or net-metering), they have hardly been applied in the RE-H market. The primary reason is the associated challenges of monitoring and verification as the heat is generated and consumed on site – mostly without interference with a heat grid. However, the ongoing trend towards digitization will reduce the costs for measurement and verification (M&V) of RE-H systems.

PBIs can either refer directly to the generated unit of heat or work indirectly through a credit system, where total operations of heat providers are considered. Because the latter is mostly applicable to large centralized heating grids, they are not addressed here. Policymakers who design PBIs for heating should especially address the following (IEA-RETD, 2015):

- **Baseline for Rates** – The rate per unit of RE-H can either refer to the generation costs of specific technologies or to the avoided costs of fuel. Furthermore, the rates can differentiate between different technologies, system capacities, and sectors.
- **Definition of Useful Heat** – As heat is generated and consumed on site, PBIs can create perverse incentives to actually use more heat than is needed. Such cases have already been observed, for example, in combined heat and power systems, where power was sold to the grid and on-site consumption was rewarded separately. To avoid perverse incentives, the heat load needs to i) serve an actual purpose, ii) be economically viable (heating was previously done by a non-renewable source), and iii) be measureable and verifiable.
- **Energy-Efficiency** – For larger heating loads in particular, there is a need to ensure that certain minimum energy efficiency standards are met.
- **Measurement & Verification** – All PBIs need a reliable and economic M&V system to address the standards used and the required form of institutional framework (e.g. for calibration) to be adopted.

Despite the clear advantages of PBIs for RE-H, the associated challenges in designing and implementing successful support schemes are substantial. Thus, in light of the young market, it is not expected that PBIs for RE-H will play a major role in the MENA region in the near future – or in other regions. However, with an increased application of digitization, internet of things, and smart homes, the costs of monitoring and verification of heating will come down, which can facilitate the implementation of PBIs. Furthermore, the risk of underperformance can also be overcome when private sector third parties supply heat to an end-user through “Heat Purchase Agreements”, which are offered by an “Energy Service Company” (ESCO). In this case, ESCOs have an intrinsic interest to maximize performance of the RE-H equipment while the off-taker will not purchase “uneconomic” heat. Thus, fostering the ESCO business model will also foster performance-based heat production.

8.5 Policies to Lower Soft Cost

Any investment is associated with two kinds of costs: Direct investment costs and soft costs. Soft costs refer to those accruing by business processes. Part of the soft costs, such as margins or supply chain costs, are completely independent of the product and thus will not be considered here. Table 3 shows some examples of soft costs, which have a specific relevance for RE-H, and lists potential measures for lowering them (IEA-RETD, 2015).

Type of Soft Cost	Description	Policy Option
Customer acquisition	All costs for marketing and lead development until closing of a contract.	<ul style="list-style-type: none"> • Awareness raising campaigns • Market transparency • Finance feasibility studies • Identifying promising segments
Installation labour	Cost of staff – it is especially high when there is low availability of skilled labour	Education and training
Permitting	Permission for specific projects (mostly not relevant for heating) or approval for a specific product to be added to an eligibility list	Covering permission costs
Taxes and customs	All fees associated with the import and sale of RE-H equipment – especially customs and value added taxes.	<ul style="list-style-type: none"> • Tax waiver • Custom waiver

Table 3: Example of soft costs and associated policy options

8.6 Policies to Lower Financing Costs

All RE technologies are capital intensive in the beginning but create attractive returns over their lifetime. Therefore, lower costs of finance directly increase the returns of RE assets. Governments can support the uptake of RE-H by mechanisms which lower the costs of finance. These depend, as mentioned before, mainly on i) the general costs of finance in a market, ii) the technical risk, and iii) the commercial risks as well as the transaction costs. Each can be influenced by policies to lower the costs of RE finance.

- **Interest Rate Buy-Down** - Governments, which often have access to comparatively lower cost finance (either commercial or through climate finance), can provide credit-lines which are dedicated only to renewables and have lower interest rates. This approach has been already proven in numerous countries, as well as in the MENA region (Abdelhadi, 2015).

- **Loan Guarantees** – The real and perceived technical and commercial risks have a major impact on the costs of finance. Partial risk guarantees can reduce the risks for investors and thereby lower the costs of finance. Risk guarantees can either be comprehensive or only address specific risks (Abdelhadi, 2015).
- **Bill repayment** – For smaller installations in particular (e.g. domestic SWH), the operational costs for servicing a loan can become relatively expensive. An attractive option to lower the operational costs and default risk is repayment linked to utility payments. Bill repayment induces good payment behavior because users who default will have their installments sanctioned by the utility and could ultimately be disconnected from their electricity supply grid (Abdelhadi, 2015). In the MENA region this approach has already been successfully applied in Tunisia, as discussed in chapter 6.3 (Trabacchi, 2012).
- **Standardized Contracts** – Standardization lowers perceived risks and transaction costs for all parties and therefore fosters market acceleration. With respect to finance, this holds particularly true for loan and energy supply agreements as discussed below (Abdelhadi, 2015).

Furthermore, there are conventional market approaches (not directly impacted by policies), such as aggregation of projects, which lower the costs of finance.

In addition to the above mentioned aspects, which hold for all kinds of projects, ESCOs (third-party business models) offer the most prominent example for innovative financing. According to the model, a third-party will cover the investment costs, own the plant, and sell the energy to the off-taker. The advantages of ESCOs are that end-users do not have to cover the capital investment, there are no technical risks for the end-user, and the plants are operated by specialized companies which ensures maximum generation. In addition, ESCOs often have better access to finance. However, adding a third-party will also add costs to the project, which would commonly lower the returns for the end-user. Transaction costs in particular become more expensive. Thus, the approach is not suitable for all kinds of projects. ESCOs can be a great accelerator for RE-H projects in particular. Thus, any policy which fosters the ESCO market will also accelerate RE-H. The most important aspects are standardization of contracts and interest rates buy-down.

Besides, there are further approaches to innovative RE & EE financing such as a securitization vehicle, referred to as SV in Table 12, which acts like a trust. The objective of this vehicle is not to operate the plant over the long term, like an ESCO, but rather to finance the project for the end-user. The vehicle only engages once the project has been successfully commissioned, since by then the technical risks will have been minimized. The provider is still responsible for guarantees and the end-user needs to pay the vehicle regardless of the produced energy.

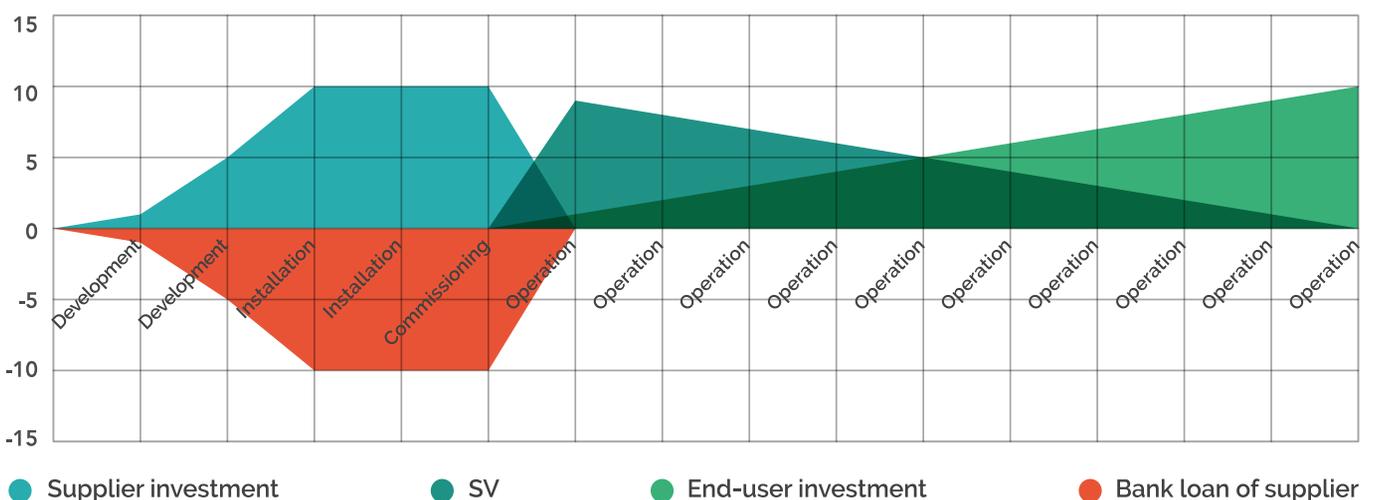


Figure 12: Concept of a securitization vehicle for renewable energy or energy efficiency (TrustEE, 2019)

8.7 International Policies for Renewable Heat

As mentioned above, RE-H policies are much less common than policies for renewable power.

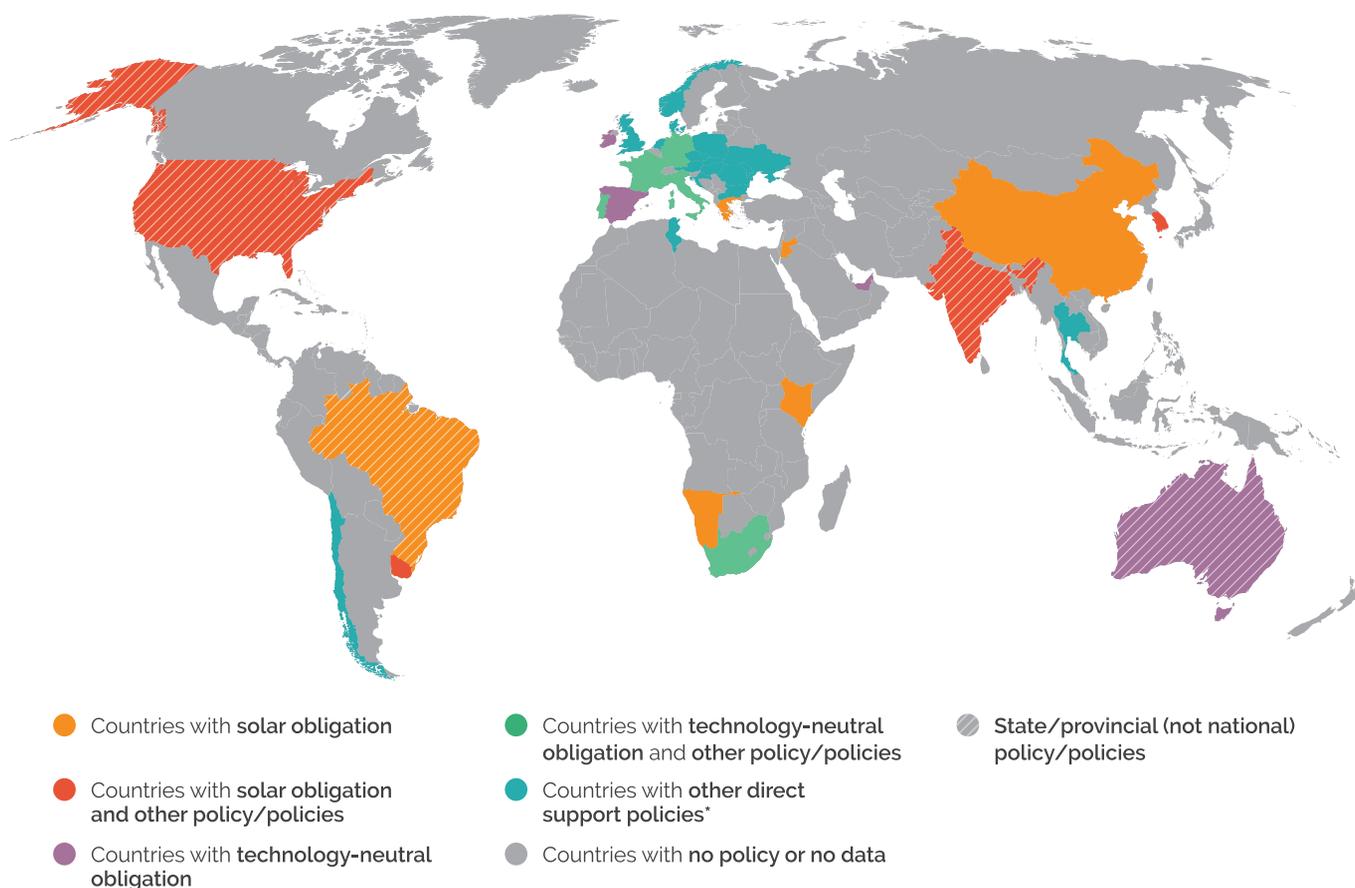


Figure 13: Countries with renewable energy heating policies (IRENA, IEA and REN21, 2018)

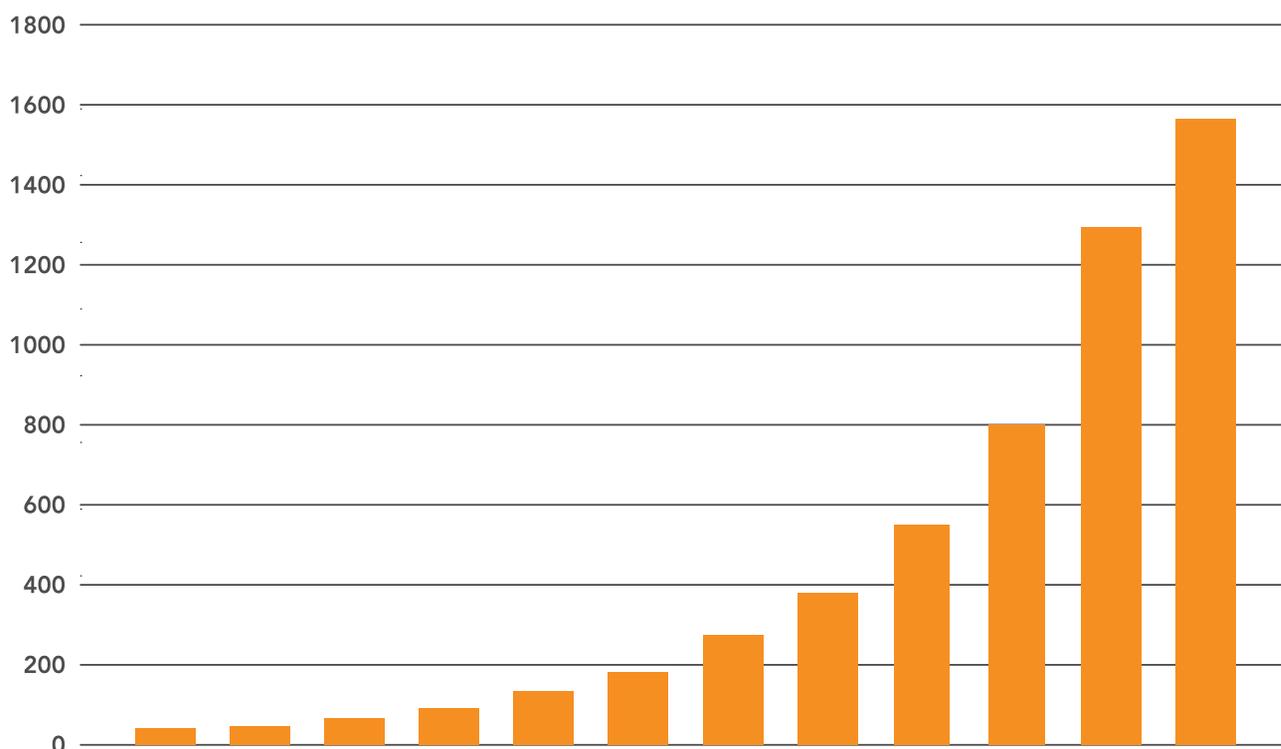
Despite the relative neglect of dedicated policies for RE-H in comparison to renewable power, there are various success stories for effective policies. Two are described below. The first refers to setting overall heating targets and the second addresses a specific heating segment.

The European Union set a dynamic target for RE-H in its latest directive (2018/2001) on the promotion of the use of energy from renewable sources (EU, 2018). Article 23 stipulates that the share of RE-H and cooling shall grow by a factor of 1.3% annually until 2030. Member states are to decide on their own how to achieve the targets. While the actual value of 1.3% per annum lacks ambition, the implementation of a dynamic target with flexibility with respect to the implementation is promising as it gives a strong signal to the market.

One of the most well-known success stories for RE-H is the Danish District Heating (DH) systems. While it was first applied in Denmark in the 1920s, district heating gained significant momentum after the first oil crisis in the 1970s when a law on heat supply was passed in 1979. First, communities had to map supply and demand of heat and second, prepare the options for the future supply of heat. Based on that input, an overall heat plan was prepared in a third step. Since then, district heating has become a significant player in Denmark. Today more than 60% of the population is connected to district heating, which provides both space heating and domestic hot water. The major part of the heat is supplied by combined heat and power plants, which used to be primarily coal-fired. In 2012 a new energy strategy was issued, with the objective of attaining carbon-free energy supply by 2050, where heating plays a major role. Thus, apart from biomass, solar thermal heating has become more and more important with

the total installed collector area growing by 50,000 m² to more than 1,000,000 m² in the last decades, as shown in Figure 14. There are a number of key reasons that explain why renewable district heating has become so successful in Denmark. First, the infrastructure for district heating driven by electricity had been in place already. But electric heating was banned in the 1980s. Consequently, RE-H could start to replace fossil-fuel based heat. Second, renewable technologies used to be supported with capital subsidies, which have been phased out by now, allowing for competition among all available technologies today. Third, heat supply companies are not allowed to make profit but only to cover their expenses (depreciation of assets and financing costs). Forth, RE-H is, unlike fossil fuels, exempted from taxes. Fifth, buildings are required to connect to the district heating network and thus have a strong incentive to actually use it (DEA, 2017). Due to the above measures, Denmark is considered today one with the most wide-spread use of DH and possesses the highest rate of SWH for DH per capita worldwide.

Thousands (m²)



● Installed collector area

Source: PlanEnergi, data provided to the IEA

Figure 14: Installed solar thermal collector area in Denmark (Collier, 2018)

Source: PlanEnergi, data provided to the IEA

The Denmark case study is a particularly good example of an effective RE-H policy. It is based on a long term strategic target, sets clear objectives, and uses incentives to foster preferred options but does not prescribe a specific solution.

8.8 Summary on Renewable Heat Policies

Numerous policy options for RE-H are available and have already been proven successful. Yet as each has its specific strengths and limitations, policies need to be carefully selected and designed. Unfortunately, in-depth policy evaluation data, beyond direct costs and benefits, is not available. In order to generate in-depth policy assessments, reliable data needs to be available. When this is the case, an assessment would ideally address, as mentioned above, the following: **i)** adequacy of targets, **ii)** appropriateness of a policy to address a specific barrier, **iii)** deployment progress, and **iv)** cost-effectiveness of deployment (Collier, 2018). Data about RE-H in the MENA region is difficult to identify relative to data about RE. For example, even though solar thermal is a key technology for the region, the availability and quality of data about solar thermal heating is low. The strengths and limitations of the renewable heat policies described above are summarized in Figure 15. As can be seen, each policy instrument has its own specific (dis-)advantages.

<i>Policy Instrument</i>	<i>Strengths</i>	<i>Limitations</i>
Targets (Generic or technology - or fuel specific)	Provides clear direction of travel; sends signals to consumers and industry.	Not effective on their own; need policy measures for implementation.
Financial incentives (e.g. Grants, tax credits and investment subsidies)	Improves the competitiveness of renewable heat compared with fossil fuels, can help address barrier of higher capital costs.	Support levels subject to frequent changes due to shifting political priorities.
Heat generation-based incentives (Similar to feed-in tariffs)	Provides support over a long period of time.	Can entail high cumulative costs; does not deal with issue of high upfront costs.
Carbon or energy taxes (With exemptions for renewables)	Serves as important price signal; deals with externalities; can be ratcheted up over time.	Politically difficult to implement; exemptions often given to certain industries, making them less effective.
Renewable portfolio standards (quota for renewable heat)	Provides certainty over deployment levels.	Generally much less ambitious for heat than for electricity.
Mandates , often technology-specific (e.g. Requiring installation of solar water heaters)	Mandatory; provides greater certainty of increased deployment.	Mostly for new-build only, thus covering limited share of heat demand; rarely applied to existing buildings.
Building codes (Setting energy performance requirements, including for renewables)	Provides an opportunity to align energy efficiency with renewable heat requirements.	Mostly for new-build only, thus covering limited share of heat demand; rarely applied to existing buildings.
Ban on fossil fuel heating options	Mandatory; provides greater certainty of success.	Suitable alternatives must be available.
Information (e.g. Awareness campaigns and labelling)	Essential for creating awareness about options, costs and benefits.	Most effective when done as part of personalised energy advice which is expensive to deliver.
Standards and certification	Important for supply chains and increasing consumer confidence.	Unlikely to result in much deployment without financial incentives.
Capacity building (e.g. Installer training)	Important for supply chains.	Unlikely to result in much deployment on their own.
Demonstration (pilot) projects	Important for testing local suitability.	Unlikely to result in much deployment on their own.

Table 4: Strengths and weaknesses of renewable heat policies (IRENA, IEA and REN21, 2018)

For policy makers designing RE-H policies, the process depicted in Figure 16 is recommended. First, a sound data basis needs to be available upon which long-term targets can be based. Afterwards, cross-sectoral implementation plans need to be developed before finally specific measures can be designed. As stated already, reliable data is absolutely crucial but they are hardly available in the MENA region. Thus, better data collection about heat demand and supply as well as renewable resources for heat generation in the MENA region is of utmost importance.

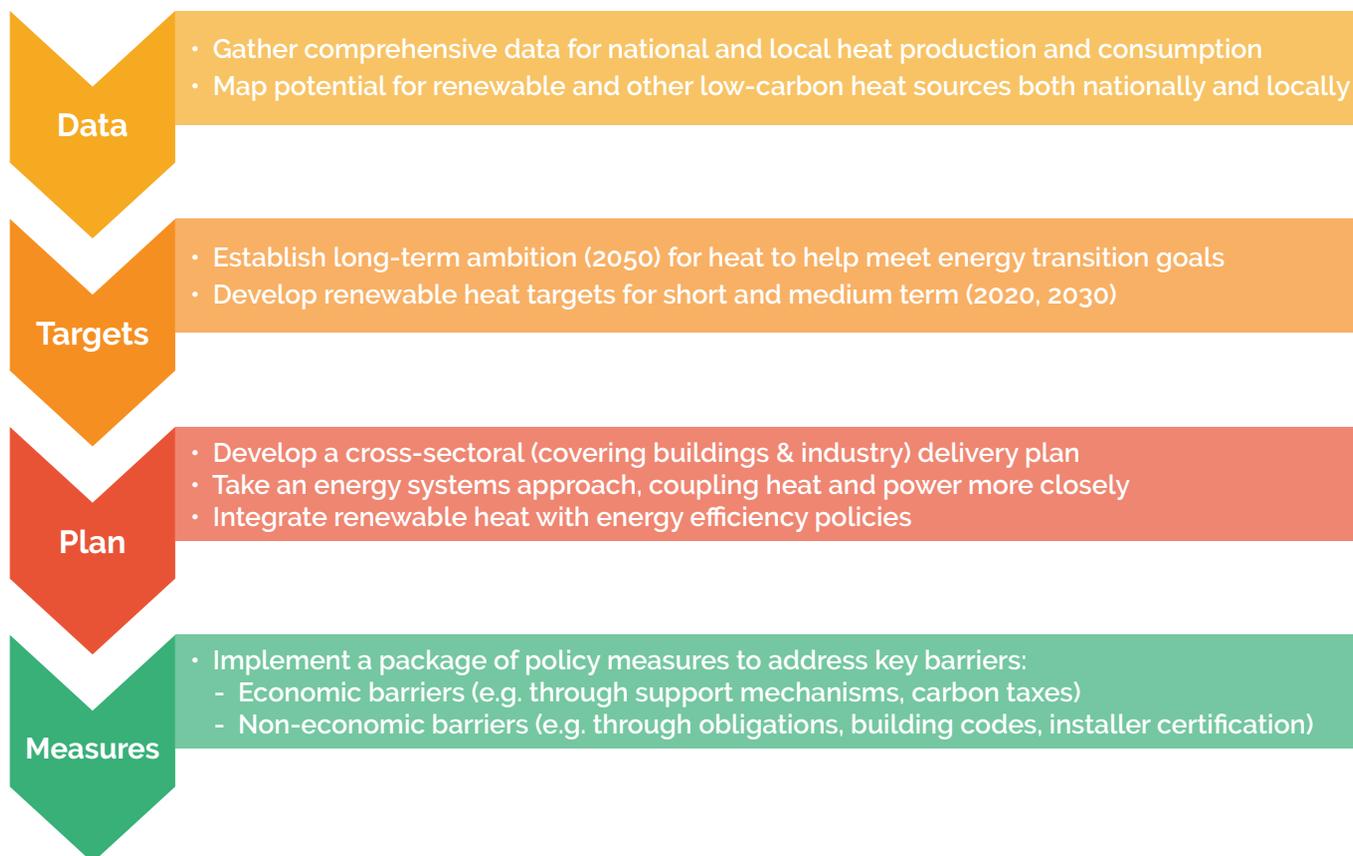


Figure 15: Recommended process for establishing renewable energy heating policies (Collier, 2018)

8.9 Policy Recommendations for Renewable Heat in the MENA Region

Based on the above, these are the recommendations for RE-H policies for the MENA region:

- **Importance of targets** - The major heat demand comes from industrial heating and the building sector and both have very long investment cycles. Since rapid changes in these sector cannot be expected, long term targets are even more important (IRENA, IEA and REN21, 2018). This holds particularly true for the MENA region, where most countries have no or unspecific targets for RE-H.
- **Specific policy design** - Policies for RE-H need to reflect the specific circumstances (e.g. market segment and resource potentials) and prevailing barriers that need to be overcome (IEA, 2018). Due to the specific circumstances of the MENA region, the role of solar thermal energy is especially important.
- **Capitalize on Success Stories** - Policies to foster RE-H are available and have already been applied successfully, including in the MENA region. Yet, more knowledge exchange on RE-H specific policies is required to capitalize on the existing experience and to efficiently implement new policies.

- **Need for data** – In order to design specific policies, a good understanding of the heat demand, the current heat supply, as well as the available renewable resources is important. Because the RE-H market is fragmented, this is more challenging compared to the electricity sector. Nevertheless, countries need to invest more resources in data collection on RE-H. This holds particularly true for the MENA countries, where data availability on RE-H is acutely poor.
- **City level policy** – The building segment can also be addressed by cities or municipalities (IRENA, 2017). While national governments implement legislations, cities can affect the uptake of RE-H through urban planning. District heating systems for example are best implemented when new neighbourhoods are developed and most feasible when supplied with waste heat from industries or power plants. Furthermore, space can be set aside to set up solar thermal fields. In addition, the mapping of geothermal resources can be better done on a community level than on an individual or country level.
- **Alignment with EE (building insulation)** - Even though there is less demand for domestic heating in most MENA countries, compared with other regions, the region's cold season creates demand for heat. The short and temperate winter season makes capital intensive RE-H less feasible, and therefore, there should be more focus on EE measures in buildings (e.g. thermal insulation), particularly given that EE will also reduce the demand for cooling during the summer.
- **Alignment with EE (industrial waste heat)** – RE-H policies for industrial heating need to avoid crowding out the use of waste heat (IRENA, IEA and REN21, 2018).
- **Ensure a level playing field between RE and fossil fuels** - The pricing and taxation of fossil fuels has the most direct effect on the viability of RE-H. With abundant fossil fuel reserves and low fuel prices, this continues to be the major barrier for adopting RE-H in/within the MENA countries (IRENA, 2017).
- **Sector coupling** – Linkages with other sectors, particularly power generation should be taken into account.
- **Support demonstration projects** – In order to increase investor confidence in new technologies, even when they have been successfully applied elsewhere, demonstration projects are important in early market phases (IRENA, 2017).
- **Review** – Policies need to be reviewed and adjusted regularly.

Key Takeaways – Policy Options to Foster Renewable Heat

- Numerous policy instruments to foster RE-H are available.
- Selecting suitable instruments depends strongly on the specific heat demand as well as the market phase.
- Most importantly, countries have to set legally binding targets for RE-H to induce private sector engagement.
- A major challenge for RE-H compared to RE-E is that it is more difficult to apply performance based incentives since heat is mostly not provided through centralized grids.
- Finance is of utmost importance for both RE-E and RE-H and measures to improve access to finance are needed for both markets.
- In order to successfully foster RE-H, various policy instruments need to be applied in parallel to address the various challenges.

- Data collection is also important to evaluate the effectiveness of specific policies.
- Globally, there are numerous successful best practices for RE-H policies, from different sectors, technologies, and regions.
- The MENA region has various success cases of RE-H policies .

9.0: HEATING IN THE MENA REGION

In 2016, the MENA region was responsible for more than 50% of the total primary energy supply. But the region is not only a major supplier of energy to the world, but also a major consumer. In the past four decades the total final energy consumption (TFEC) increased twentyfold, with the industrial sector being the largest consumer, as shown in Figure 17 (IEA, 2018).⁴

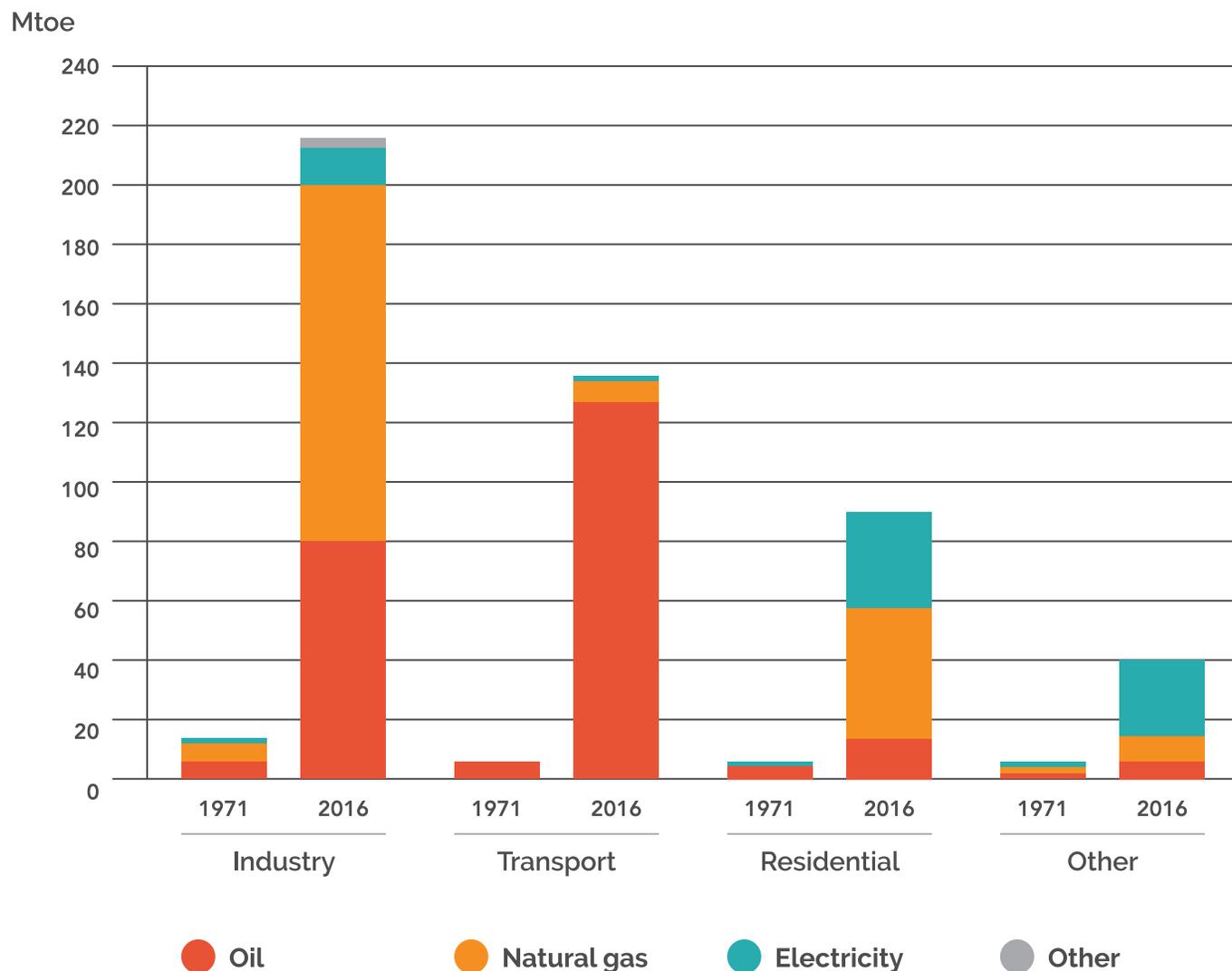


Figure 16: Total final energy consumption by sector and fuel for the Middle East (IEA, 2018)

⁴ Here the data from (IEA, 2018) refers only to the Middle East and thus does not include North Africa. Accordingly the numbers are even higher when the complete MENA region is considered.

9.1 Demand and Prices for Heat in the MENA Region

IEA, Energy Balances, 2019						
Country	Total Final Consumption	Industry	Transport	Residential	Other	Heat (estimated) ⁵
	mtoe	mtoe	mtoe	mtoe	mtoe	mtoe
Algeria	37,8	6,0	15,1	10,3	6,3	9,5
Bahrain	6,4	2,1	1,2	0,8	2,3	2,5
Egypt	58,0	13,5	18,7	13,8	12,0	17,7
Jordan	6,1	1,1	2,8	1,3	0,9	1,5
Kuwait	19,2	7,3	4,8	3,0	4,2	7,3
Lebanon	5,0	0,7	1,9	1,8	0,6	1,2
Lybia	10,0	0,6	7,1	1,1	1,2	1,2
Morocco	15,4	2,9	5,6	3,9	2,9	4,3
Oman	20,3	10,5	4,2	1,4	4,3	8,9
Qatar	18,0	6,6	4,4	1,5	5,5	7,0
Palestine	0,0	0,0	0,0	0,0	0,0	0,0
Saudi Arabia	139,6	42,3	45,8	14,1	37,3	46,7
Syria	6,4	1,5	2,1	1,3	1,4	2,0
Tunisia	8,0	2,1	2,4	2,1	1,4	2,6
U.A.E	52,6	28,4	11,7	3,8	8,6	23,1
Yemen	2,4	0,3	0,9	0,9	0,2	0,6

Table 5: Final energy consumption in the MENA region in 2016 (IEA, Energy Balances, 2019)

⁵ Estimations based on the following authors' assumptions: Industry (65%), Transport (0%), Residential (30%) and Other (40%)

The price for heat generated from the combustion of fossil fuels in the MENA countries differs significantly for various reasons.

- **Different fuels** – Different fuels are being used to provide thermal energy. These fuels possess different prices (natural gas < heavy fuel oil < liquified petroleum gas < diesel < kerosene) and vary in the levels of their emissions of CO₂ and other pollutants. The availability of natural gas, which is commonly the least expensive available fuel, depends on access to a centralized grid.
- **Price adjustments** – In some countries, such as Saudi Arabia and Egypt, fuel prices are fixed by the government and only adjusted irregularly, whereas in other countries, such as Jordan and Lebanon, a mechanism is established where prices are regularly (e.g. monthly) adjusted in accordance to international fuel prices.
- **Subsidies / Sectoral pricing** – In some MENA countries (such as Egypt), different prices for the same fuel are used for different end-users. Poor groups as well as heavy industry receive fuel subsidies. Because they do not reflect accurately actual costs, subsidies lead to sub-optimal allocations of resources. While they can be justified based on socio-economic factors, subsidies need to be carefully designed to minimize their negative effects.
- **Currency for trading** – In some MENA countries (such as Jordan and Lebanon), bulk quantities of fuels are traded in USD, which brings a further variable in pricing over time.

Due to the reasons mentioned above, it is complex to provide a comprehensive picture of fuel pricing in the MENA region. The differences of prices can in total sum up to more than 700% within the region. Broadly speaking, Jordan, Lebanon, and Morocco have made the most progress in eliminating energy subsidies. For the other countries, the picture is more complex. Some of them have substantial resources and thus subsidize energy only indirectly.

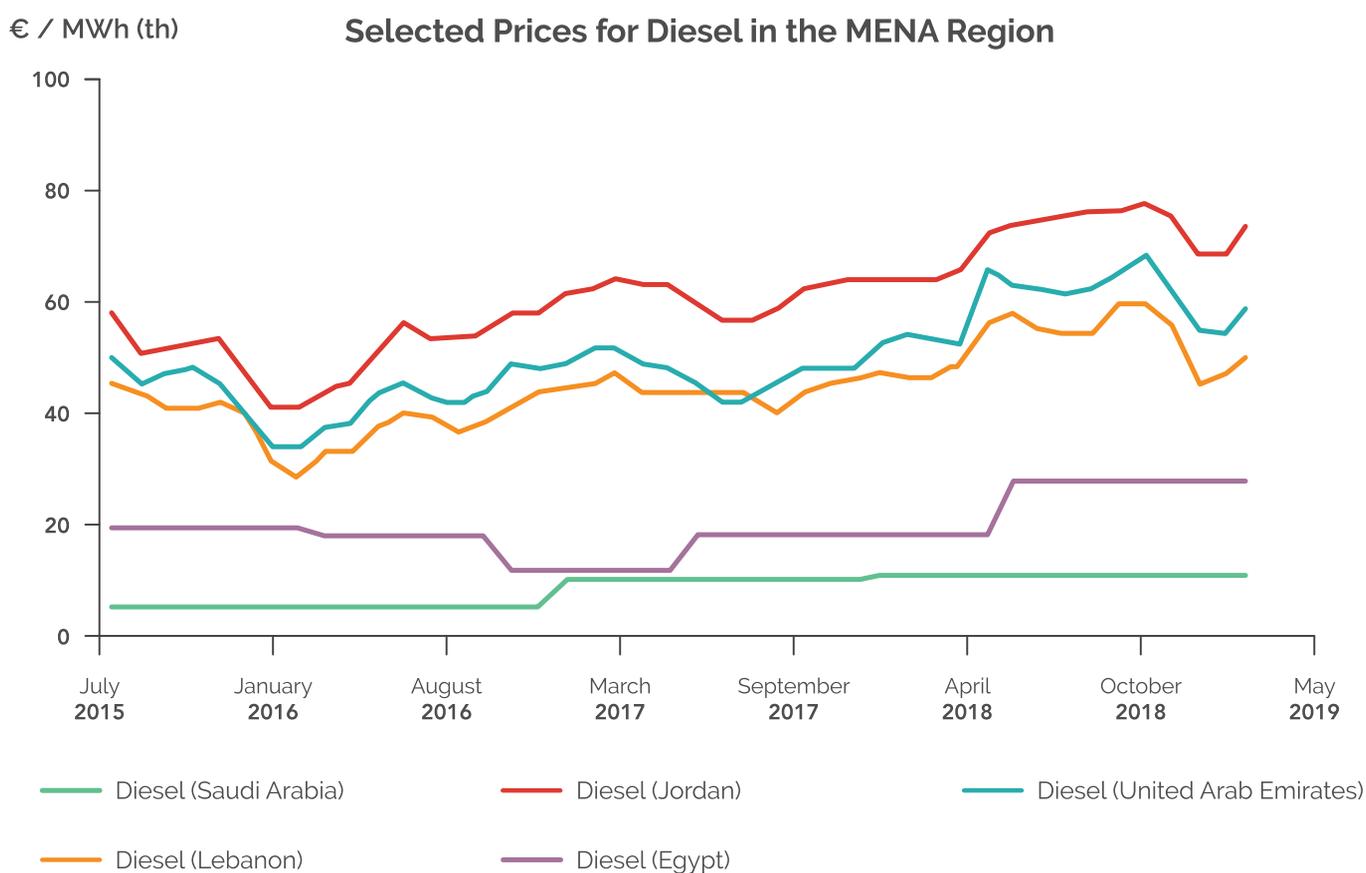


Figure 17: Diesel price in selected MENA countries (authors information)

9.2 A Case Study: Heat Policies in Lebanon

Lebanon imports almost all of its fuel. Therefore, energy is comparatively expensive in Lebanon, which makes EE of a greater importance. In 2010, Lebanon issued its first National Energy Efficiency Action Plan (NEEAP), in which a strategy to optimize energy consumption was rolled out. NEEAP also addressed heating. After implementing several initiatives, a second NEEAP (LCEC, 2016) was prepared in 2016. A few heat measures are described below. It is important to note that the measures in the NEEAP are merely proposals – some of them are implemented and / or transcribed in official regulations or laws. The targets however are not binding as long as they are solely in the NEEAP.

Double wall ordinance

In Lebanon, the building sector is responsible for about ¼ of the total consumed energy. According to NEEAP, improving thermal insulation is the most important measure to increasing EE inside buildings. In an initiative to increase EE inside buildings, the NEEAP proposed to increase thermal insulation in buildings through an obligatory building code. This practice will not only reduce energy consumption for heating in winter, but also for cooling in the summer. The proposal in NEEAP plans to address 100 buildings with a total area of 100,000 m² by 2020 and to reduce energy consumption for heating and cooling in buildings by around 43% per unit covered. However, as discussed the proposal addresses only a small share of the buildings.

Solar water heaters

Solar water heating was already considered in the first NEEAP (2011-2015) and is also addressed in the second National Renewable Energy Action Plan (NREAP) (2016 – 2020), where a goal of 1.05 million m² installed solar thermal collector area is envisaged. The current deployment is around 50.000 m² per annum. To achieve the targets, there are three support mechanisms. First, residential users can get a low interest loan from the Banque Du Liban (BDL) for projects below USD5,000. Second, there is a list of pre-qualified suppliers which builds up trust in the market. Finally, there is a small grant component of USD200 for projects financed through the above mentioned loan and implemented from pre-qualified companies (LCEC, 2019).

Energy efficiency in Lebanese industry

The LCEC (Lebanese Center for Energy Conservation) and the Ministry of Industry targeted 20% of the large industries (hiring at least 5 workers and operating on area >100m²) to reduce energy consumption by implementing 7 major measures. Thermal energy accounts for around 50% of the total energy consumed annually in the Lebanese industrial sector. Due to its importance, several measures were proposed to address thermal energy generation and consumption, amongst which are improvements in preheating, heat recovery, and cooling systems. However, as discussed this proposal addresses only a small part of the industrial sector.

Minimum Energy Performance Standards (MEPS)

MEPS targets 5 main energy appliances in Lebanon, of which one is heating. The proposal aims to address the efficiency of these systems by the following two procedures: a mandatory energy consumption labeling and an eco design directive. The main scope of these measures is to shift the Lebanese appliance market towards more efficient products. This is mainly achieved by increasing consumers' awareness and eliminating worst performing appliances from the market.

To sum up, the Lebanese authorities and decision makers presented solid content in their NEEAPs, which reflects their environmental awareness and readiness to tackle various challenges that may face Lebanon in the future. However, there are few concerns that must be addressed. First, the report only discusses proposals to future policy. Regardless of how good and effective the proposals may appear, without a clear strategy and policy legislation process, the proposals may not be reflected into actual projects. Second, some of the established targets lack ambition.

Finally, the discussed proposals often relied on international financial support. While it is a reasonable approach for some measures to secure international climate finance, others can already be implemented directly without the need for further finance. Furthermore, if these measures would be directly transferred to legally binding targets, it would send a much stronger signal to the private sector which can then build up the required capacities for implementation.

9.3 A Case Study: PROSOLI Scheme in Tunisia

In 2005, the Tunisian government initiated a national support and funding program called "PROSOL" (Programme Solaire) in joint collaboration with the United Nations Environment Programme (UNEP), Société Tunisienne d'Electricité et de Gaz (STEG), the Italian Ministry for Environment, Land, and Sea, and Agence Nationale pour la Maitrise de l'Energie (ANME) in order to develop the market for solar thermal collectors in Tunisia (Baccouche, 2014). The three major objectives of PROSOL were to:

- Level the competitive playing field between SWH and subsidized LPG (Liquified Petroleum Gas) systems;
- Build up both the demand and supply sides of the SWH market; and
- Overcome the absence of consumer credit for RE investments and reliable credit performance.

The major results of PROSOL were as follows:

- The installation rate of solar water heaters grew from 10,000 to 60,000 m² per year, as shown in Figure 19;
- A net positive effect was generated for the Tunisian Government (expected saving of USD100 million over the lifetime of the systems vs. initial investments of USD20 million);
- The creation of 10,000 new jobs; and
- Emission reductions of more than 700 kt of CO₂ would be achieved over the lifetime of the systems (Trabacchi, 2012).

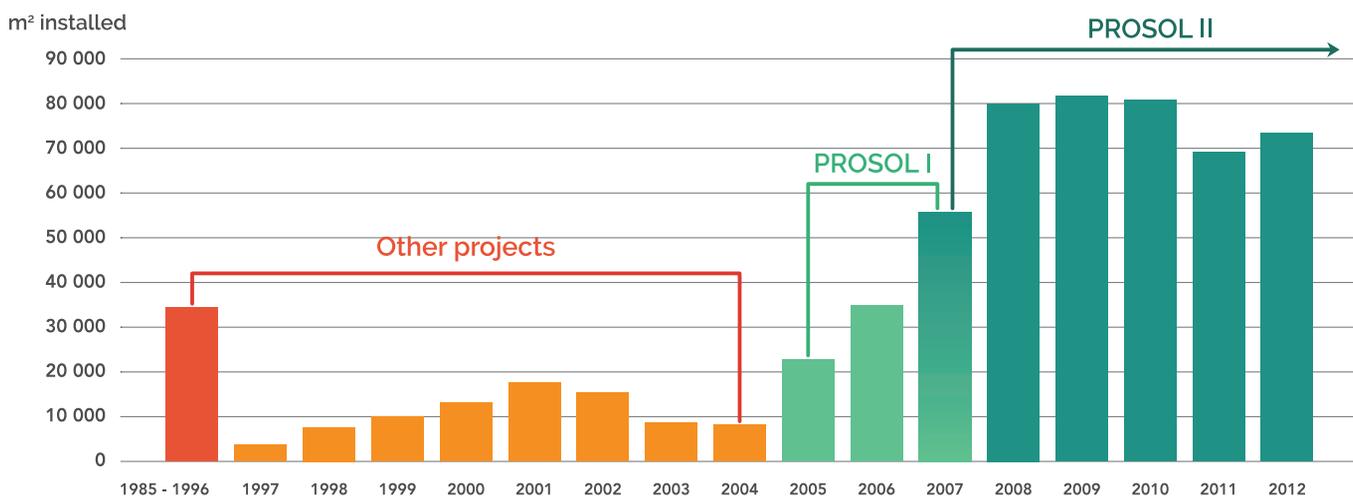


Figure 18: Installation rate of solar water heaters in Tunisia (UNEP, 2014)

While there were various specific PROSOL schemes for different sectors, the PROSOL II scheme is described below due to its comprehensive approach. Only some key aspects are highlighted:

- Direct support to private end-users - A capital cost subsidy provided by the Tunisian government of 20% of the system's cost (Mahgoub, 2015).
- Indirect support - Tax exemptions and reduced customs.
- Loan repayment through the public utility (STEG) reduced administrative costs for banks and good payment behavior was fostered due to possible sanctions.
- Several banks were involved which increased the impact.
- Quality enforcement through certified installers (staff) and suppliers (company).
- Additional financing through international carbon markets.

The major learning for future improvements of PROSOL were (Trabacchi, 2012):

- Suppliers were not financially strong enough to provide lending and guarantees (this was changed in PROSOL II).
- Reliance on a single-financing institution can result in market distortions and potentially hamper the program's long-term sustainability.

In summary, the Tunisian PROSOL example proves that with the right approach, RE-H technologies can be fostered successfully, creating net positive effects for the country. However, as mentioned before, it also shows that comprehensive approaches are necessary which may include, inter alia: i) direct financial incentives (grants), ii) indirect financial incentives (taxation and customs), iii) awareness raising, iv) quality enforcement, and v) capacity building. A strong commitment from all stakeholders is also crucial for success.

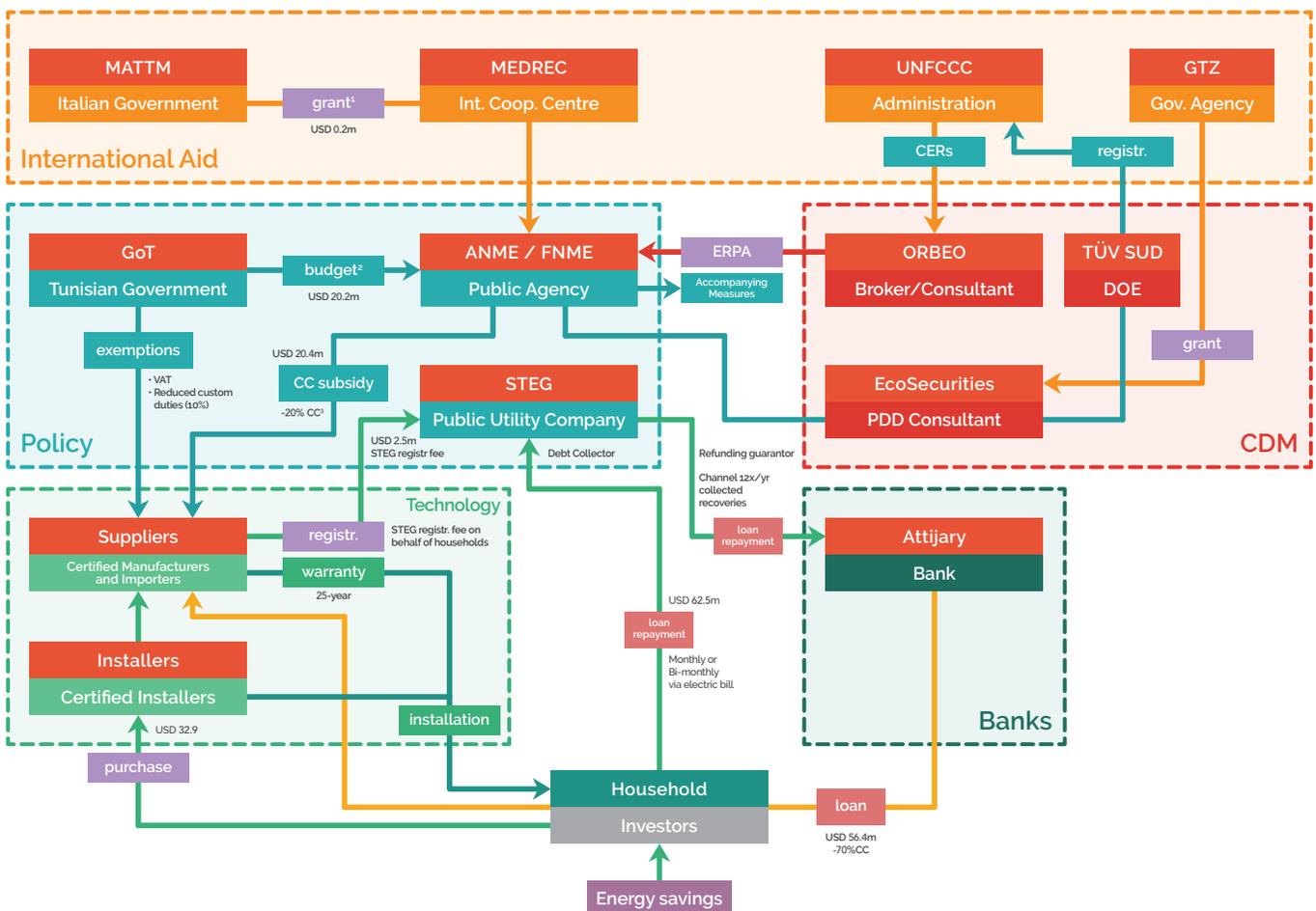


Figure 19: Prosol II support scheme (Trabacchi, 2012)

9.4 Sustainable Energy Financing Facilities: Morocco and Egypt

RE or EE measures are often supported through a technologically driven approach (e.g. a power tariff for electricity from photovoltaic). Because thermal energy optimization measures are more specific, it is more difficult to implement support measures to a specific technology. The provision of finance can be an alternative intervention which is effective for all market segments but is particularly promising for the heating market due to its peculiarities. In addition, such programs have already been implemented in the MENA region – an interesting example is the Sustainable Energy Financing Facilities (SEFF) by the European Bank for Reconstruction and Development (EBRD). This approach has initially been developed for the East European countries and only later been extended. Currently there are SEFFs in Morocco and Egypt (EBRD, 2016). The common objective is to scale up private investment in energy optimization. The characteristic feature of the SEFFs is the provision of credit lines through commercial banks acting as financial intermediaries. In addition, there are accompanying measures such as: i) technical assistance to financial intermediaries and/or to end-users and b) incentive payments. The technical assistance was especially helpful to make the financial intermediaries aware of market opportunities and to help them in project appraisal (EBRD, 2016).

SEFFs are commonly implemented in two tracks. For small measures, there are lists for eligible products which substantially reduce the transaction costs. For larger projects (e.g. CAPEX > 300,000 €), assessments are done on a case by case level.

For the heating market, the above described approach is particularly attractive because it has features that are well-tailored to the uniqueness of the heating market.

- The objective to scale up private sector investment is technologically neutral and allows the end-user to use the most suitable solution.
- The technical assistance can help to reduce at least some of the project development costs.
- A grant component facilitates the uptake of new solutions which is often still needed in the heating market. The flexible implementation allows to select suitable supports based on the specific criteria.
- A list of eligible materials reduces the transaction costs for smaller projects.

9.5 Energy Service Companies in the MENA Region

Energy Service Companies (ESCO) supply energy services to their consumers. This is particularly attractive when the consumers lack the necessary resources (e.g. financial, technical, know-how) to optimize their energy supply. Furthermore, ESCOs can make use of economies of scale. The ESCO model has repeatedly been identified by countries in the MENA region as a key actor to achieve emission reduction targets. However, the market is still in its infancy. The United Arab Emirates (UAE) is the most prominent example for applying ESCO concepts in the region with at least 25 ESCOs in operation. Yet, even there most of them only have realized less than five projects (CEBC, 2019).

One reason why the ESCO market in the Emirates is ahead might be the foundation of Ethiad ESCO,⁶ a so called "Super ESCO". Ethiad ESCO does not directly implement projects but is responsible for

⁶ <https://www.etihadesco.ae>

i) the accreditation of ESCOs operating in the UAE and ii) developing and tendering projects. In 2017 the Public Investment Fund in Saudi Arabia established Tarshid,⁷ a Super ESCO, with the objective of developing the market for energy services in the Kingdom. In 2018 the "Société d'Investissements Energétiques"⁸ in Morocco, which previously was responsible for financing RE and EE, was transformed into a Super ESCO as well (Rboub, 2018) but so far there are no details about its future activities available. To which extent these entities will succeed in developing the market still remains to be seen.

9.6 Further Case Studies: Sustainable Heating Projects in the MENA Region

District Heating and Cooling at Abdali in Amman (Jordan)

Abdali is a new residential and commercial district in Amman. Because it was developed as a whole, a district heating and cooling project was implemented in order to reduce the energy and water demand for heating and cooling. In total an annual saving of 40% (around 40,000 MWh) was expected,⁹ but results have not yet been communicated.

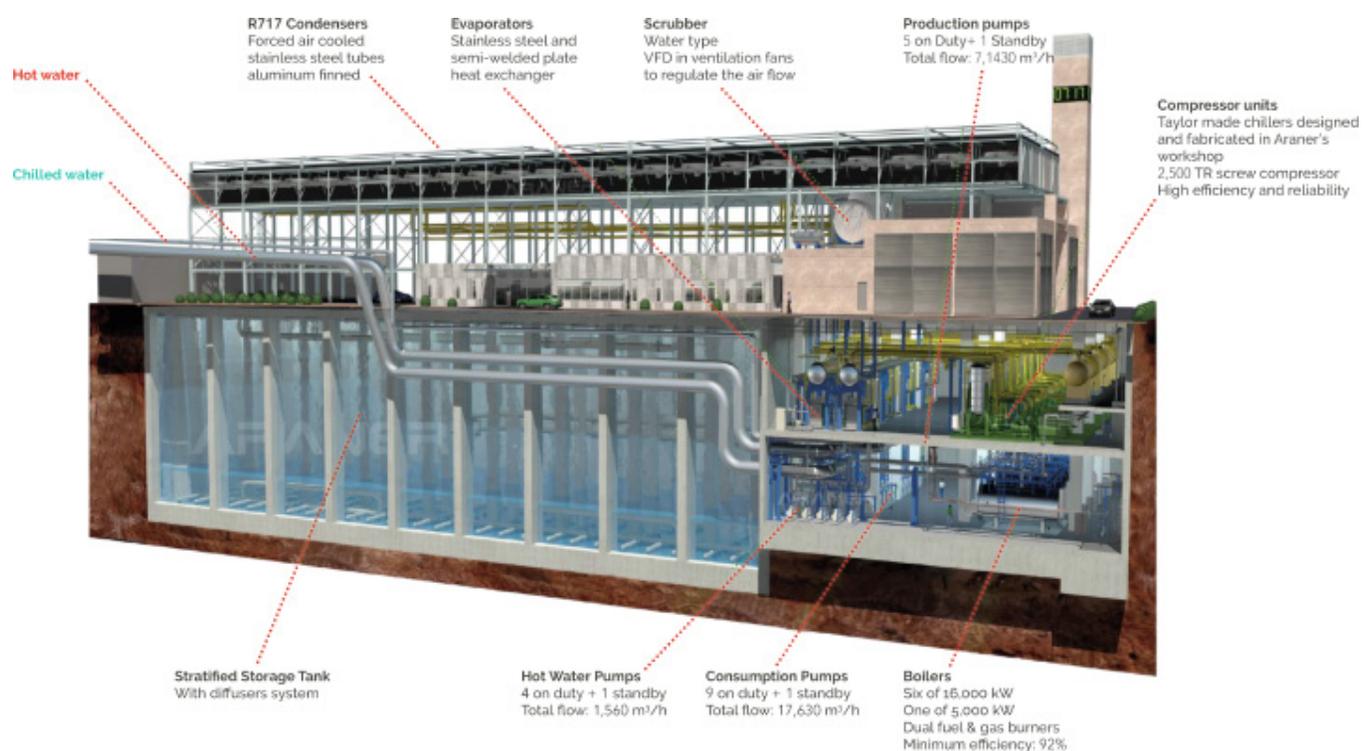


Figure 20: Abdali district heating and cooling plant (EBRD, 2017)

Sector	Residential / Commercial
Technology	District heating and cooling
Capacity	85 MW _{th} heating / cooling capacity unknown

⁷ <https://www.tarshid.com.sa>

⁸ <http://www.siem.ma>

⁹ More information is available here: <https://www.araner.com/blog/abdali-jordan-district-cooling-solution/>

Solar water heating at Albashir Hospital in Amman (Jordan)

Hospitals have a very high heat demand for heating, cooking, sterilization, and laundry. Heat is commonly provided through centralized fuel-fired steam boilers. The Al Bashir Hospital in Amman had an annual fuel demand of about 2 million liters of diesel. Recently the hospital installed a SWH plant on building roofs with a total aperture area of 1,133 m² and a thermal capacity of 0,8 MW. The SWH plant reduces the hospital's diesel demand by around 10% and has a payback time of less than 5 years.¹⁰



Figure 21: Solar water heating system at Al Bashir Hospital In Amman (Epp, Solarthermalworld, 2018)

Sector	Hospitals
Technology	Solar water heating
Capacity	0.8 MW _{th}

Solar water heating at Princess Nora Bint Abdul Rahman University in Riyadh (Kingdom of Saudi Arabia)

Princess Nora Bint Abdul Rahman University in Riyadh, with 13 faculties and numerous other facilities, including a hospital, already had a district heating system. To reduce the demand of the fuel-fired boiler a SWH system with a capacity of 25 MW was installed in late 2011. The expected savings are in the range of 40% of the annual fuel demand.¹¹

¹⁰ <https://www.solarthermalworld.org/content/solar-hot-water-system-jordanian-hospital-pays-44-years>
¹¹ <https://www.solarthermalworld.org/content/saudi-arabia-25-mwth-plant-produces-heat-womens-university>



Figure 22: Solar thermal collector field at Princess Noura University in Riyadh (Epp, 2012)

Sector	Education
Technology	Solar water heating
Capacity	25 MW _{th}

Biomass combustion for industrial process heating at Midabriq (ceramic sector) in Midar, Morocco

As indicated above, industrial process heating is responsible for the largest share of heat demand in the MENA region – and is almost entirely covered by the combustion of fossil fuels. The ceramic sector is rather energy intensive and has a very large process heat demand for the dryers. Process heat in Morocco is supplied through the combustion of fuel no. 2 which is, at least in comparison to natural gas in neighbouring countries, comparatively expensive. Midabriq has installed a biomass boiler which mainly uses olive pomace as a feedstock. Compared to fuel oil, the costs per MWh dropped by around 65%.¹²



Figure 23: Biomass boiler at Briqueterie Samarra in Tangier (Beralmar, 2015)

Sector	Industry
Technology	Biomass
Capacity	Unknown

¹² More information is available here: <http://www.beralmar.com/en/news/show/id/60>

10.0: CONCLUSIONS AND RECOMMENDATIONS

Heating is responsible for a major part of the total energy demand. Even though residential heating is of less importance in the MENA region, the total heat demand in the region is substantial and without an accelerated uptake of clean heating solutions the CO₂ emission reduction targets cannot be achieved. However, despite its importance the market is insufficiently addressed by both the public and the private sector.

Compared to electricity the heating market is more complex. In order to address a specific market segment a profound understanding of its characteristics is important, especially with respect to the spatial and temporal distribution of the demand as well as the required temperatures. A major challenge today is that data is insufficient in both quantity and quality on a micro and macro level. This holds particularly true for the MENA region. A further challenge is that heat is commonly generated and consumed on-site, without a centralized supplier.

While the MENA region lags behind in the uptake of clean heating, there are numerous success cases in the region for policies as well as projects. Thus, there is good experience to build on.

On the national policy level, the following is recommended to policy makers:

- Setting and regularly reviewing binding long term targets for clean heat.
- Identifying key target sector(s) with high potential and/or synergies with other policies.
- Implementing data collection for target sectors, for both heat demand (e.g. load profiles) and supply (e.g. installation rates of SWH), to facilitate policy design and review.
- Implementing, and where already available, enforcing thermal building codes given the long life time of buildings and hence long term effect.
- Identifying and fostering uptake of renewable heating technologies through comprehensive acceleration programs for no-regret options (e.g. biogas generation from organic wastes, minimum energy performance standards, waste heat recovery).
- Fostering specific working groups (e.g. industries, cities with similar conditions) where lessons learned are exchanged.
- Initiating incentive programs for new infant markets to overcome initial market hurdles and accelerate market development.

On the MENA region level the following is recommended to policy makers:

On the research level, the following is suggested:

- Examining existing best practices for applications with high regional replicability (e.g. optimized heat supply for hospitals in the MENA region).
- Examining and comparing cost-effectiveness of existing policies.
- Examining the relationship between the heating and the cooling markets and developing optimized technical and policy approaches for thermal energy supply.

- Examining the relationship between the heating and the power markets with consideration of the specific national grid and power supply conditions.
- Examining the indirect effects of clean heat supply (e.g. job creation, reduced emissions that have adverse effect on human health and environment).

This report provides the first comprehensive overview on the status of clean heat in the MENA region, the potential for policy options, and existing best practices. Due to insufficient availability of accurate data, lessons on specific sectors, market segments, or potentials cannot be drawn from this work but need further detailed assessments.

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