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GREENING SPACE HEATING IN ECA:
WHAT WILL IT TAKE?

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TOWARD A FRAMEWORK FOR THE SUSTAINABLE HEATING TRANSITION

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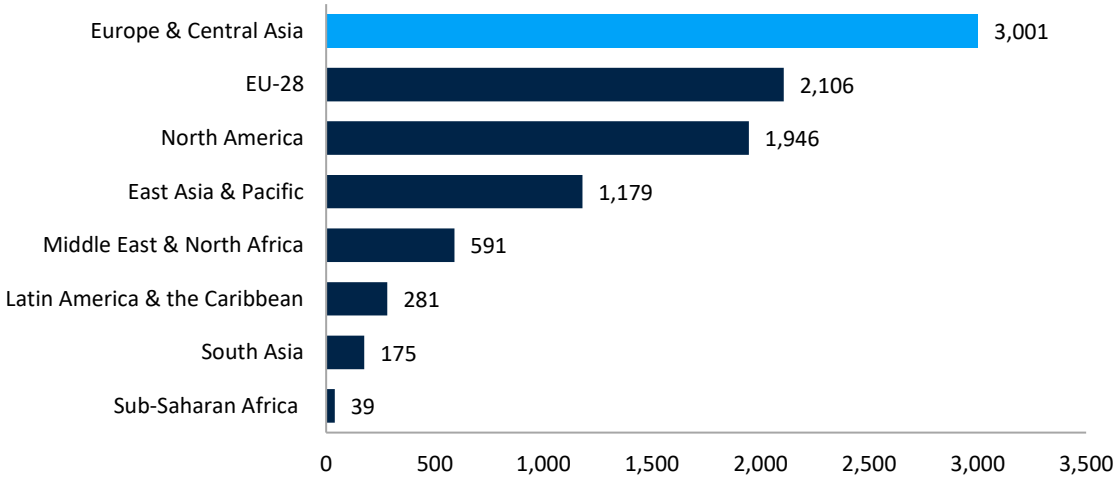
SPACE HEATING IN EUROPE AND CENTRAL ASIA TODAY:

ONE-QUARTER OF ENERGY USED VERY INEFFICIENTLY FOR HEATING

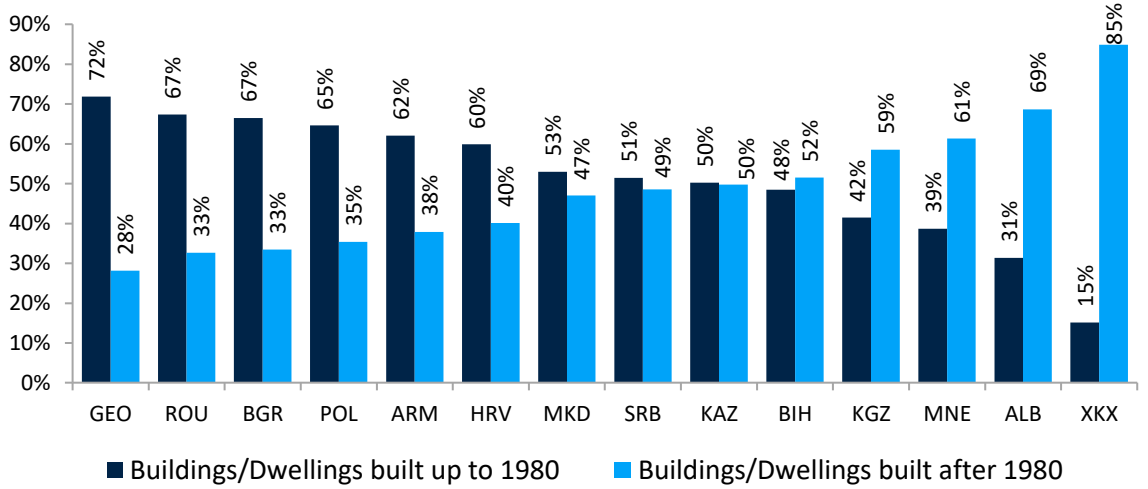
The coldest region in the world



Average Heating Degree Days (2000-21), weighted by population

Source: IEA and CMCC, Weather for Energy Tracker, 2021

With an old building stock



Age of Housing Stock in ECA

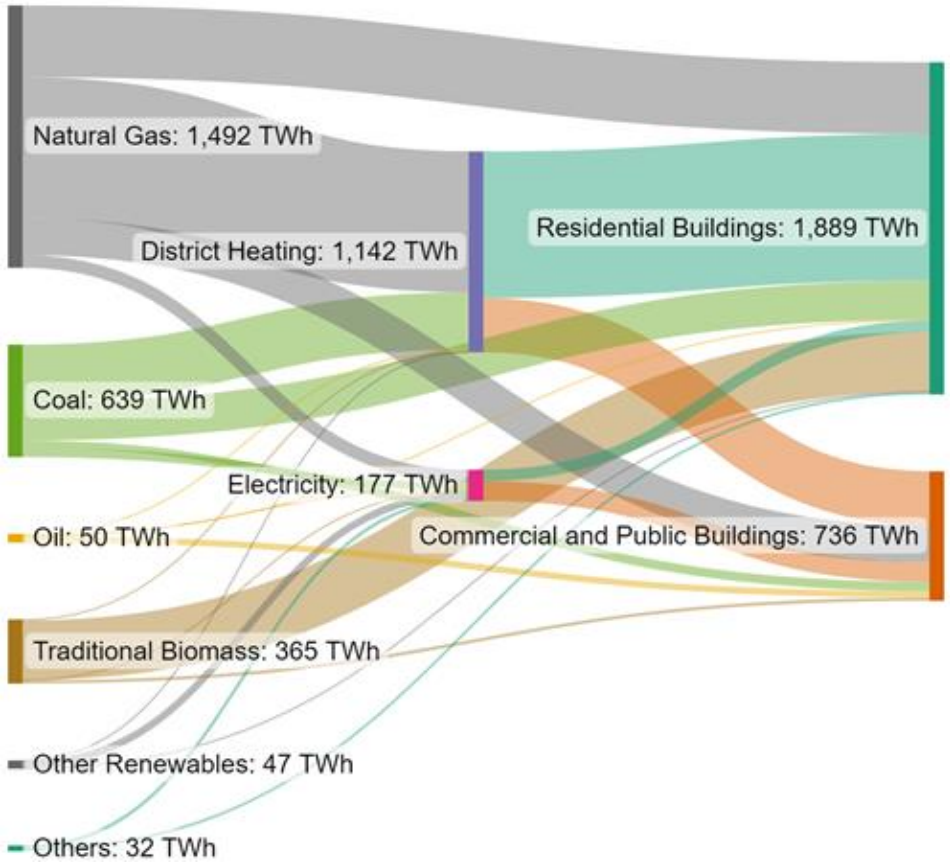
Source: World Bank

- **24% of total energy demand** is the annual space heating demand of the buildings sector
- **Aging, very inefficient, poorly maintained** building stock
- Many buildings use **2-3 times more energy** than Western European countries (kWh/m^2)
- **Heterogeneous region** in terms of housing and demographics

HEAVY RELIANCE ON FOSSIL FUELS AND TRADITIONAL BIOMASS IS HIGHLY POLLUTING AND CONTRIBUTES TO DEFORESTATION

- Space heating demand is heavily **reliant on fossil fuels**:
  - Fossil fuels **83%**
  - Unsustainable biomass (firewood) **14%**
- With DH and electricity disaggregated, space heating demand is supplied by natural gas (57%), coal (24%), traditional biomass (14%), oil (2%), other renewables (2%)
- **Urban**: Natural gas, electricity, and DH
- **Rural**: Traditional biomass and coal
- Space heating results in **high pollution:**
  - 22% of total regional CO_2 emissions
  - Almost 50% of all $PM_{2.5}$ emissions (80-90% in winter)
  - 302,000 deaths every year
  - A welfare cost of US$305 billion (7% of GDP) annually.

Estimated Building Sector Space Heating Supply in ECA, by Fuel (Energy Data)



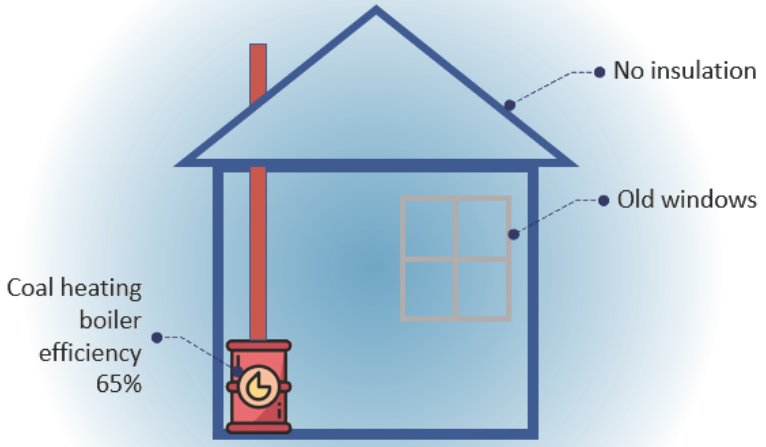
Source: World Bank estimates based on best available data.

HEATING SECTOR IS VULNERABLE TO PRICE FLUCTUATION, CAUSING HIGH FISCAL BURDEN, IMPLICIT ENERGY INEFFICIENCY TAX ON THE POOR

- High energy costs and **large subsidies** for fossil fuels for heating represent a **huge fiscal burden:** ECA direct **fossil-fuel subsidies US$115 billion** in 2020 (IMF).
- **34% of residents are energy poor.**
- The poor face two unappealing choices: **reduce heating** or **revert to cheaper, often dirtier fuels.**

Lower-income families cannot afford simple energy efficiency investments or more efficient heating systems, therefore burdened with chronic heat losses, higher energy bills, and lower quality of heating.

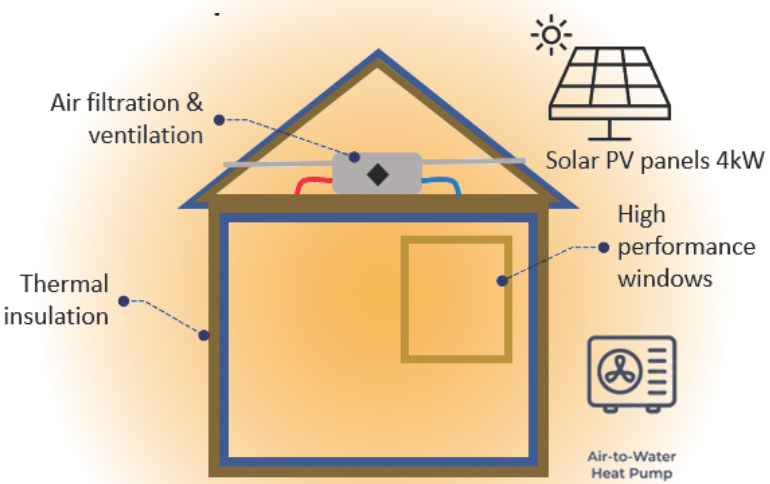
UNRENOVATED SINGLE-FAMILY HOME



Annual heating bill:

US$2,501.3
per year

FULLY RENOVATED SINGLE-FAMILY HOME



0-US$461.5
per year

RAPID ASSESSMENT SHOWS MOST DH UTILITIES ARE UNDERPERFORMING

- DH serves ~30% of ECA's population (~18% excluding Russia)
- 18 DH utilities surveyed from Bulgaria, Kyrgyz Rep., Poland and Serbia over a 5-year period (2017-21).
- **Key financial indicators**

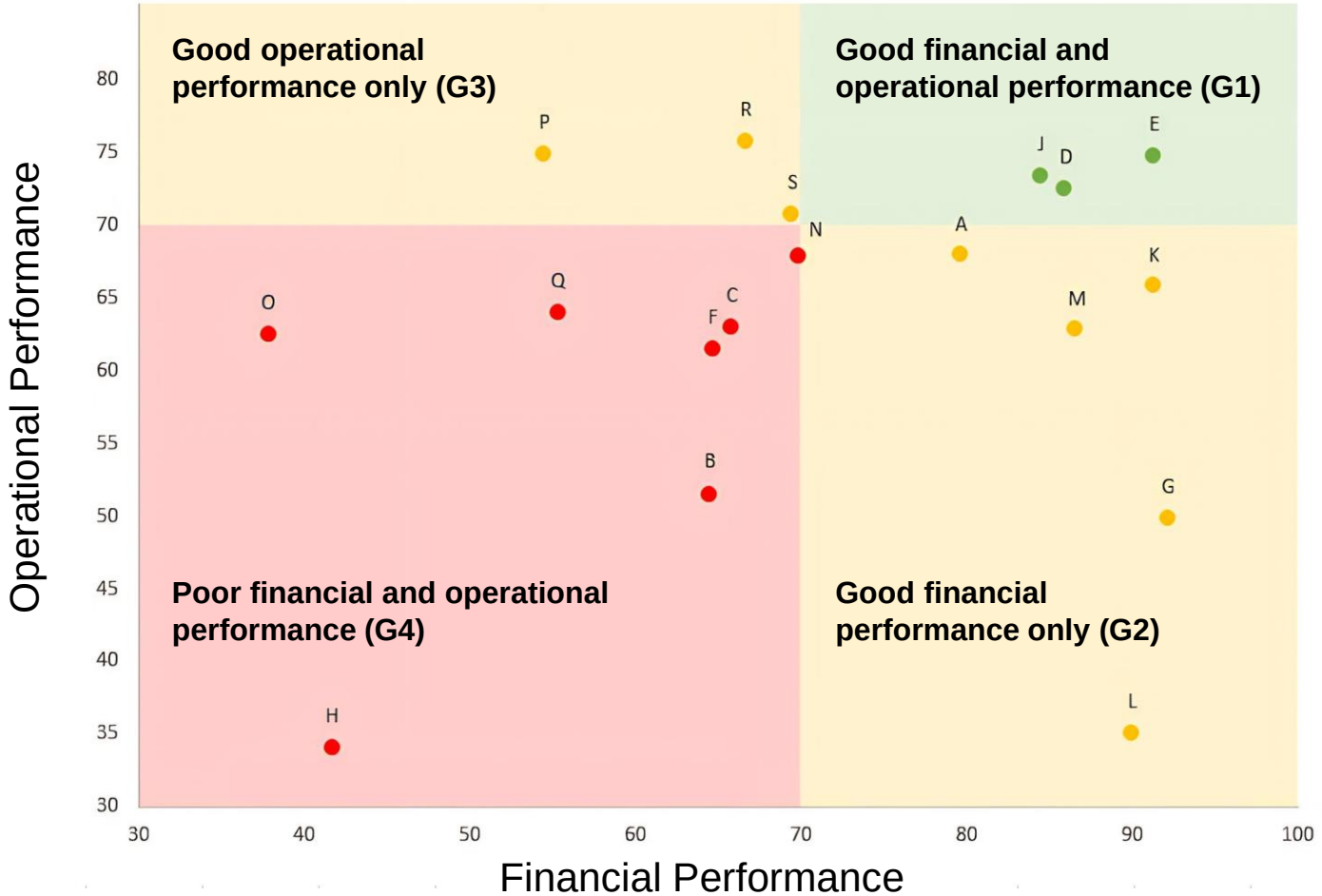
	Indicator
1	Cost-recovery (%)
2	Average Tariff (US$/kWh)
3	Average Cost (US$/kWh)
4	Collections (%)
5	Profit Margin (%)

- **Key operational indicators**

	Indicator
1	Production Efficiency (%)
2	Distribution Efficiency (%)
3	Specific Heat Consumption (kWh/m^2)
4	Water Replacement (Ratio)
5	Heat Demand Density (MWh/m)
6	Substation Metering (%)
7	Building Metering (%)

Results

- 3 were in Group 1 (good financial and operational performance)
- 5 were in Group 2 (good financial performance)
- 3 were in Group 3 (good operational performance)
- 7 were in Group 4 (poor financial and operational performance)



EMERGING RANGE OF POSSIBLE FUELS, TECHNOLOGIES, AND TECHNOLOGICAL IMPROVEMENTS

- Huge **opportunities to provide cleaner heating** sources from renewable energy and other sources. Many examples now in EU countries.
- Past incentives for cleaner DH supporting large CHP plants (more efficient and less polluting than heat only boilers).
- Revised EU Renewable Energy (RE) Directive will **increase the annual RE for heating and cooling by 1.3% each year** and include RE-based heating and cooling in local and regional city infrastructure planning.

Cleaner Heating Fuel Options

Waste Heat	Common in northern and western Europe
Biomass/Biogas	Common in EU
Geothermal	Common in EU
Hydrogen	Emerging
High-Tech Solar Collectors	Emerging
Waste Incineration Based Cogeneration	In use on pilot basis
Waste Gasification-Based Cogeneration	Emerging
Biomass Gasification	In use on pilot basis

Cleaner Technology Options

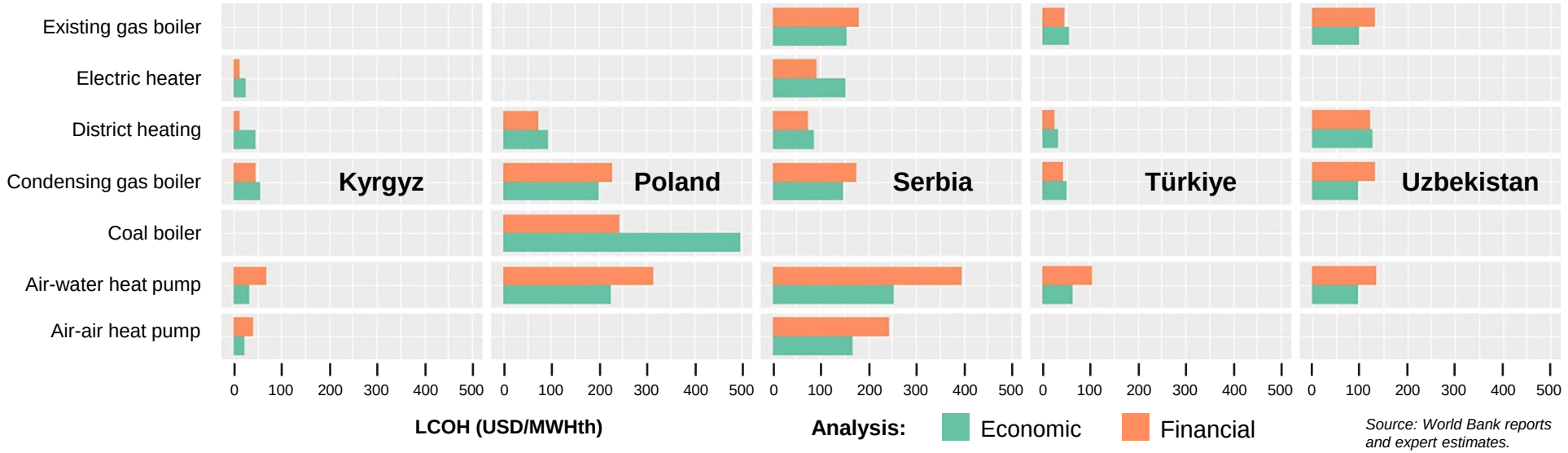
Heat Pumps	Emerging
Low-temperature DH	Common in EU
Heat Storage	In use
Building-level substations	Common in EU and ECA
District cooling	In use on pilot basis

LEAST-COST OPTIONS FOR RESIDENTIAL SUSTAINABLE HEATING DEPEND ON FUEL COSTS, URBAN VS. RURAL, MFBS VS. SFBS

- **LCOH**: Armenia, Kyrgyz Republic, Poland, Serbia, Türkiye, Uzbekistan
- **Natural gas, coal, and traditional biomass** are the predominant fuels (where DH is not available or reliable).
- **Cleaner options** – heat pumps, eco-design wood/pellet boilers, condensing gas boilers – generally had the lowest LCOH; this depended on internal piping and local fuel prices.

Urban multi-family buildings

- **DH was mostly least cost** in the financial and economic analyses
- **Heat pumps generally lowest cost** in homes without internal piping
- **Condensing gas boilers** were least-cost with internal piping



Source: World Bank reports and expert estimates.

Rural single-family homes

- **Lowest economic cost:** Eco-design wood stoves and air-to-air heat pumps
- **Lowest financial cost:** Conventional coal, wood and gas heating systems

Urban single-family homes

- **Lowest cost: Air-to-air heat pumps** (where internal piping/radiators are lacking)
- For technologies that require internal distribution systems, **condensing gas boilers were usually the lowest-cost**

REDUCE DEMAND, DECARBONIZE DISTRICT HEATING, PROMOTE CLEAN INDIVIDUAL HEATING

1 Reduce Demand

Reduce heating demand through energy efficiency in buildings and changing their behaviors

- Long Term Renovation Strategies
- Financing & Incentives for Existing Buildings
- Building Codes, Performance Certificates for New Buildings

2 Decarbonize District Heating (DH)

Bolster and decarbonize DH

- Analyze Economic Viability of DH Utility
- Identify Service Improvement

3 Promote Clean Individual Heating

Alternatives for peri-urban or rural areas with low heating demand and densities

- Assess clean heating options
  - Behavior analysis
  - Gender gap analysis
- Identify Economic Alternatives to Current Individual Heating
- Develop Programs

National Sustainable Heating Planning & Roadmaps

INDIVIDUAL POLICY MEASURES ARE OFTEN INSUFFICIENT TO OVERCOME THE MULTITUDE OF BARRIERS

Individual Barriers (beyond traditional EE barriers)

Multi jurisdictional responsibilities

Heating sector policies difficult to plan and implement as they require **coordination across ministries and across levels of government**

Prevalence of unregulated markets for solid heating fuels

The **lack of formal regulation** in firewood and biomass markets, illegal and informal logging, lack of certification lead to **underpriced firewood and charcoal and unsustainable biomass** harvesting and use

Uneven access to network infrastructure

Without DH and gas, **firewood and coal are often the only affordable and readily available** alternatives in rural areas

Uneven prevalence of building-level hot water plumbing

Where there is no hot water plumbing, it is **very expensive to upgrade to more efficient heating systems** leaving many homes reliant on lower-efficiency solutions (room-level firewood, coal stoves, electric heating)

Lack of qualified service providers

Energy auditors, designers, installers **lack necessary training**

Lack of consumption-based billing for DH

Many DH providers **bill consumers based on heated floor area rather than heat consumed**, which disincentivizes energy efficiency measures

VARIOUS REFORMS CAPABLE TO PROMOTE SUSTAINABLE HEATING

Power	Gradual **phase-out of fossil fuel subsidies**, removal of direct and indirect subsidies for electricity and DH, and better targeting of cross-subsidies in electricity and DH tariffs.
	Adequate pricing of externalities associated with unsustainable heating options, such as environmental and health impacts, with complementary measures to protect the poor and vulnerable social safety nets.
Heating	**Prosumer regulations** to encourage installation of rooftop and/or ground-mounted solar PV to support the electrification of heating for buildings.
	Consider measures to **reform the DH sector**, such as unbundling heat generation from distribution and introducing standard heat supply contracts with private producers and universal consumption-based metering and billing.
	Promote sustainable biomass through the formalization, regulation, certification, and pricing of informal markets for biomass fuels (e.g., firewood, wood pellets, wood chips), including better forestry chain management and mandatory sustainability certification of biomass used for heating.
EE standards	Better design, enforcement, and updating of **building codes and certifications**.
	Enforce **energy-efficiency performance standards** for heating products.
	Create or strengthen **home-owner association (HOA) regulations** to allow them to register, vote on renovations, sign contracts, open bank account and impose homeowner fees and payments.
Air quality	Develop **air quality standards** and bans of polluting fuels and technologies.
Other	Reforms to **support businesses and skilled employment** across the sustainable heating value chain, such as: legal and market measures to improve labor conditions; improvements in building energy rehabilitation training; compulsory continuous training (“upskilling”) in new approaches/technologies for workers who are already in the sector; quality assurance for installation services, etc.

FINANCIAL MECHANISMS FOR SUSTAINABLE HEATING IN PRIVATE BUILDINGS

Various financial instruments to boost sustainable heating

Sample of Financial Instruments

- Tax credits, rebates, exemptions
- Investment grants, subsidies or rebates
- Commercial bank or EE fund loans
- Guarantees
- Utility demand-side management programs
- Financial interventions on the supply side

NON-FINANCIAL, COMPLEMENTARY PROGRAM INTERVENTIONS

Various complementary measures to support sustainable heating

Complementary measures

- Market studies, behavior norms, and practices
- Program marketing, outreach, and behavior change
- Technical information (pre-financing stage)
- Technical training
- Program monitoring, evaluation, and reporting
- Technical information (completion stage)
- Program results and lessons dissemination

KEY TAKEAWAYS

Towards a Sustainable Heating Transition

Existing institutions, systems, fuels, and technologies will have to undergo a massive shift in order to achieve the *sustainable heating transition*, along with the relevant enabling policies, financing and business models, and communications.

Other key actions needed include:

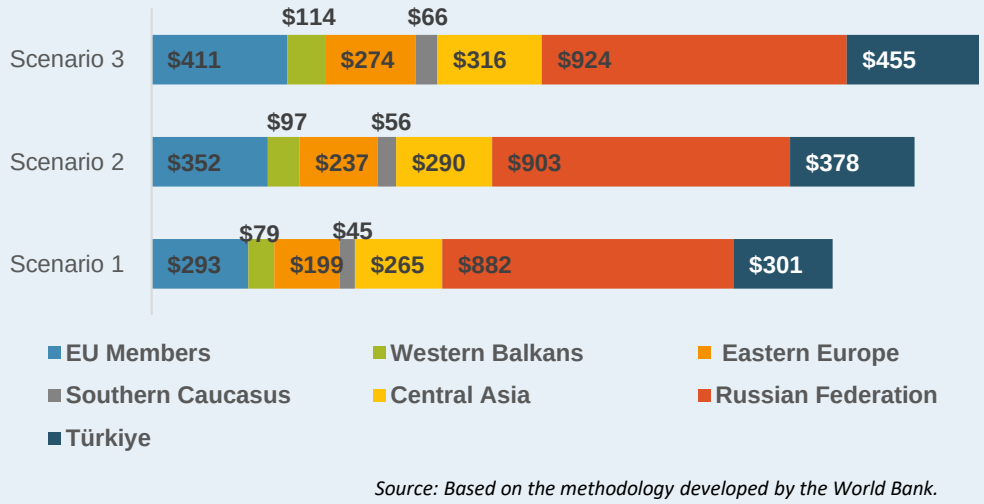
- **Push heating-related reforms**
- **Prepare country roadmaps**
- **Design and launch national programs**
- **Scale up energy efficiency measures**
- **Stimulate markets through the public sector**

INVESTMENTS REQUIRED FOR THE SUSTAINABLE HEATING TRANSITION IN THE ECA REGION WOULD BE OVER US$2 TRILLION

US$2 trillion (first-order estimate):

1. Replacing all individual systems using unsustainable fuels
2. Retrofitting existing district heating systems
3. Retrofitting 14 billion m^2 of building floor area (11 billion m^2 – residential buildings, 3 billion m^2 – commercial and public buildings).

Estimated Total Investment Costs by Sub-Region (US$, billions)



Source: Based on the methodology developed by the World Bank.

Because the costs would be predominantly borne by DH utilities, building owners and residential heating consumers, subsidies will be needed to facilitate the transition

Subsidies Financial Assessment

		Subsidies - Heating Systems	Subsidies - Building Renovation	Total Subsidies
Scenario 1	Subsidies ($billion)	$538	$1,009	$1,547
	% of total investment	65	70	68
Scenario 2	Subsidies ($billion)	$372	$1,249	$1,622
	% of total investment	60	65	64
Scenario 3	Subsidies ($billion)	$228	$1,441	$1,669
	% of total investment	55	60	59

- The **subsidies required to implement the sustainable heating transition in ECA amount to US$1.54-1.67 trillion, about 59-68% of the total transition costs.**
- While this appears high, **the subsidy level represent about 50% of the subsidies that ECA countries will spend on fossil-fuel subsidies** (US$115 billion annually) if current subsidies are maintained through 2050. This figure is about 1.3% of the region's GDP.

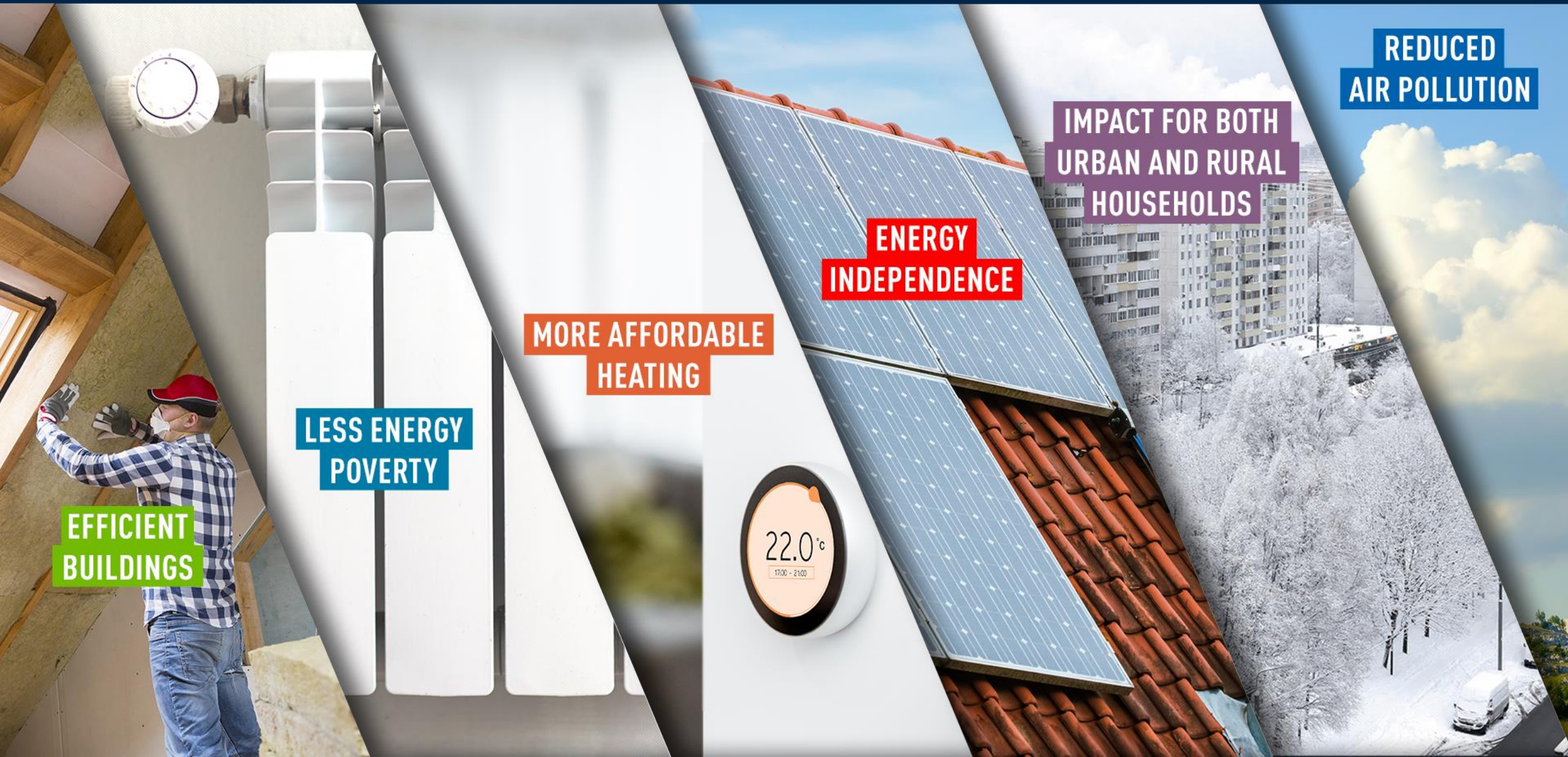
THE BENEFITS ARE GREATER THAN THE COSTS, WITH AN ECONOMIC NPV OF US$402-440 BILLION

Net Present Value (NPV) and Economic Internal Rate of Return (EIRR)

	NPV (US$ billion)	EIRR
Scenario 1	**$402**	10.14%
Scenario 2	**$421**	9.47%
Scenario 3	**$440**	9.00%

- NPV and EIRR estimates combine building energy efficiency measures and heating system replacements, an implemented rate of 3.5% per year through 2050 and an economic discount rate of 6%.
- Fuel savings (envelope retrofit and heating system replacement), reduction of CO_2 emissions, health benefits—due to NO_x, SO_x and $PM_{2.5}$ reduction—and maintenance cost savings were considered.

TRANSITIONING TO SUSTAINABLE HEATING BY 2050 COULD BRING:



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THANK YOU

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