SECTOR STUDY ON BIOMASS-BASED HEATING IN THE WESTERN BALKANS

Results of Analysis on Supply & Demand, Economic Potential, and Barriers

(Draft results - subject to change)

RENEWABLE ENERGY COORDINATION GROUP - VIENNA, 10 NOVEMBER 2016

TRACTEBEL ENGIE

WORLD BANK GROUP
Energy & Extractives

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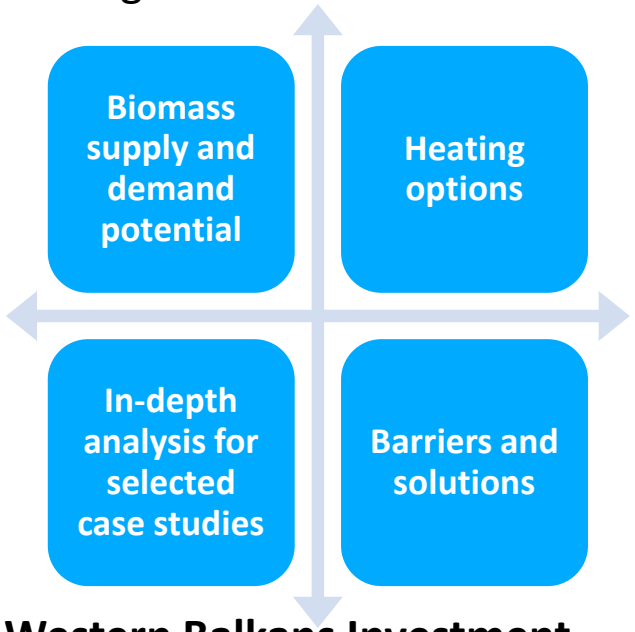
OBJECTIVE AND SCOPE OF THE STUDY

Objective: Identify viable **investment options** and **policy measures** to increase the use of biomass for heating in the region in a **sustainable** manner

Scope:



Funding: **Western Balkans Investment Facility (and ESMAP); sponsored by the Energy Community Secretariat, World Bank as implementing agency**

CONSULTANT ORGANIZATION

Consortium leader
Tractebel Engineering - Part of ENGIE Group
Present in more than 20 countries and project in over 80
3,300 Employees
Certified experience in biomass

Partner
Centre for Renewable Energy Sources and Saving (CRES) - Greece
Long-term experience in biomass and Western Balkans

Local support
South East European Consultants - Serbia

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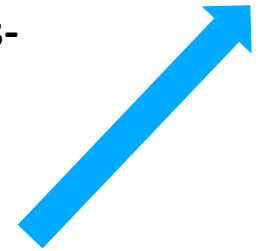
OVERVIEW OF THE PROJECT TASKS

The project activities have been divided into six tasks

- ☑ **(Task 1) Analysis of the biomass supply potential**
- ☑ **(Task 2) Assessment of heating systems in the target countries**
- ☑ **(Task 3) Assessment of economically viable biomass options for heating**
- ☑ **(Task 4) Analysis of key barriers and measures to increase the share of sustainable biomass-based heating**
- **(Task 5) Detailed assessment of using biomass for heating in selected cities/sub-regions**
- **(Task 6) Stakeholder roundtables/workshops at regional and country-level**



Case Study I – Macedonia: Preparation of a feasible Developing Program for the replacement of old/traditional wood stoves at individual household level by more efficient models, with a focus on Skopje

Case Study II - Bosnia and Herzegovina: Analysis of the opportunities to introduce or increase the use of biomass in existing DH systems in Bosnia and Herzegovina, replacing oil, gas or coal fired boilers with biomass boilers and evaluating the possibilities for biomass-based CHP

Case Study III – Kosovo: Analysis of the possible supply options using forestry and agricultural biomass residues for District Heating of the city of Gjakova

Case Study IV – Kosovo: Evaluation of the possible replacement of fossil-fired HOBs with biomass boilers in public buildings in Pristina

Case Study V - Serbia, Bosnia and Herzegovina, Croatia: The use of available agricultural wastes and energy crops for sustainable, efficient, renewable heating solutions, in the cross-border region of Serbia, Bosnia and Herzegovina, and Croatia

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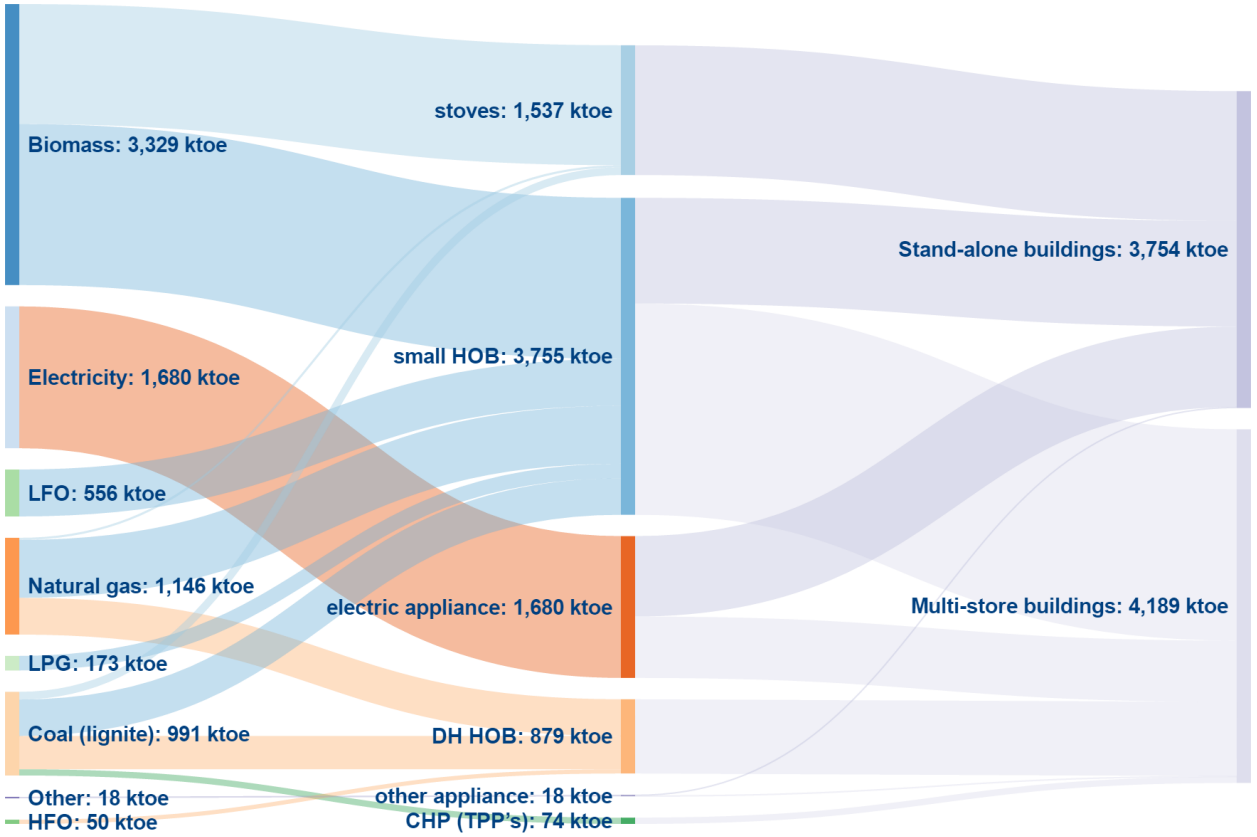
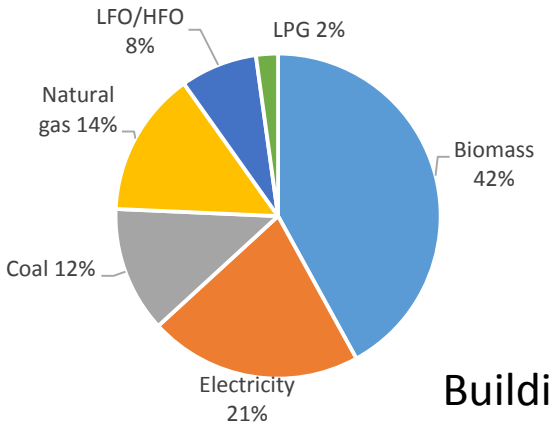
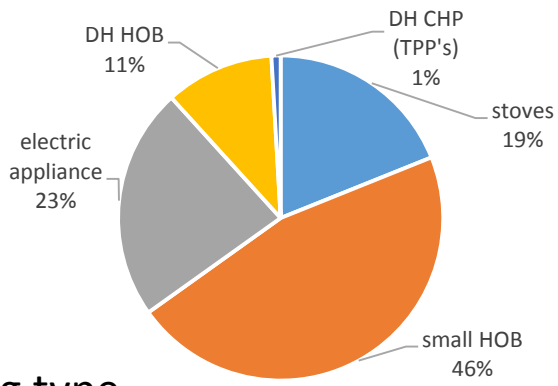
HEAT DEMAND IN WESTERN BALKANS



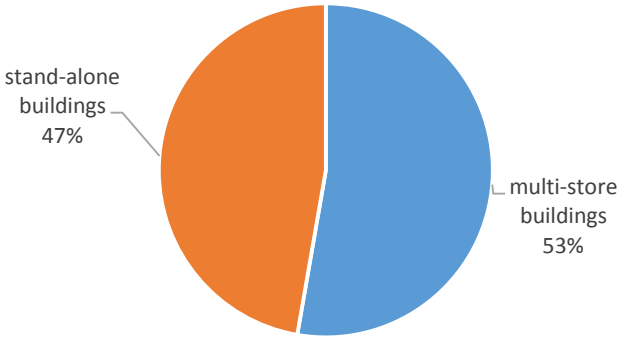
Fuel



Heating appliances



Building type



ALBANIA	
Biomass	20%
Electricity	62%
LFO/HFO	8%
LPG	8%
Other	2%

BOSNIA AND HERZEGOVINA	
Biomass	56%
Electricity	9%
Coal	26%
Natural gas	2%
LFO/HFO	7%

CROATIA	
Biomass	29%
Electricity	22%
Natural gas	39%
LFO/HFO	7%
LPG	3%

FYR OF MACEDONIA	
Biomass	39%
Electricity	41%
Natural gas	6%
LFO/HFO	13%

KOSOVO	
Biomass	54%
Electricity	21%
Coal	9%
LFO/HFO	9%
LPG	7%

MONTENEGRO	
Biomass	68%
Electricity	28%
Coal	2%
LFO/HFO	1%

SERBIA	
Biomass	41%
Electricity	9%
Coal	22%
Natural gas	20%
LFO/HFO	7%

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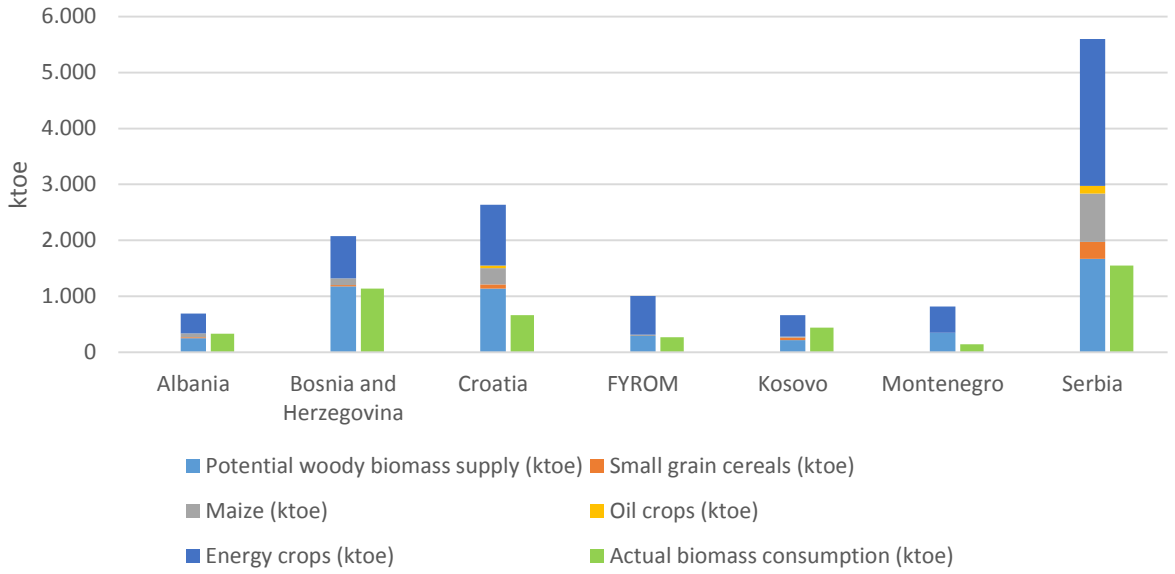
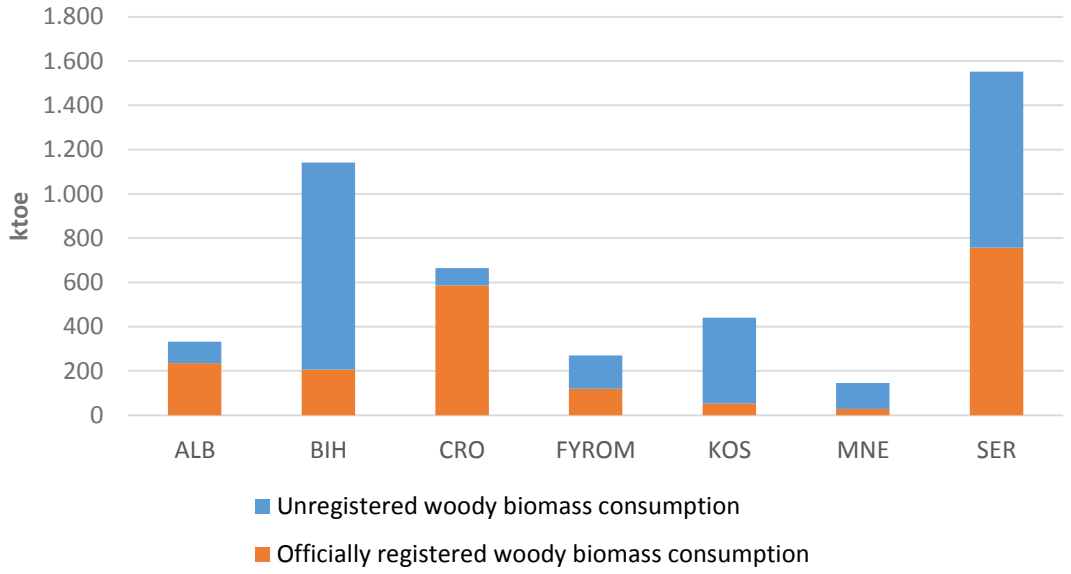
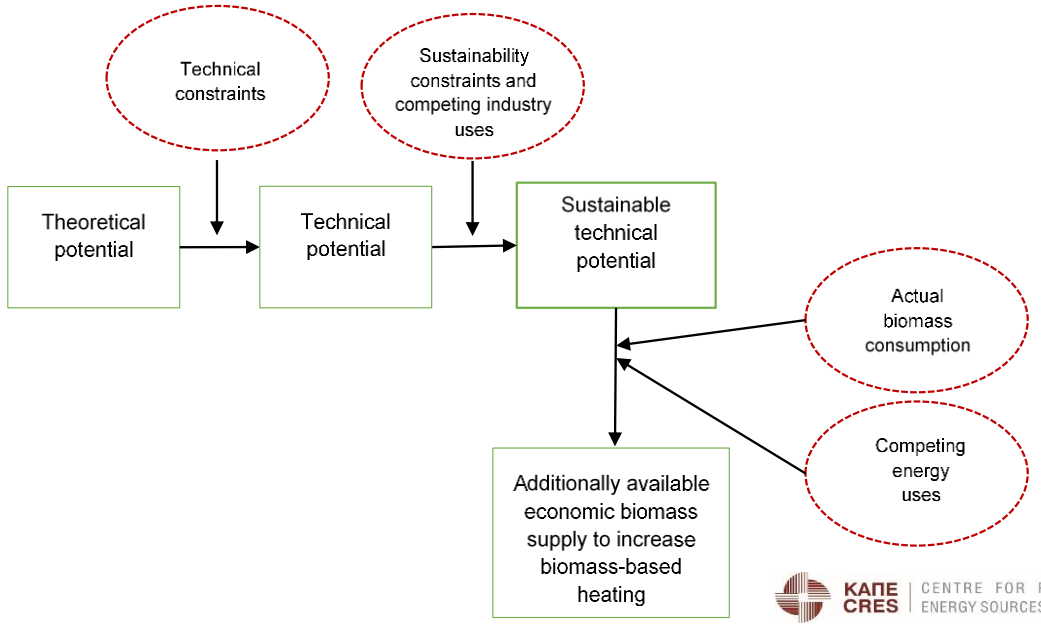
BIOMASS SUPPLY





- Current use based on woody biomass
- Agricultural residues – mainly untapped
- High level of unregistered woody biomass consumption
- Potential to increase woody biomass production by improving forest road infrastructure
- Significant potential for growing energy crops – large share of unused agricultural land in W-B countries



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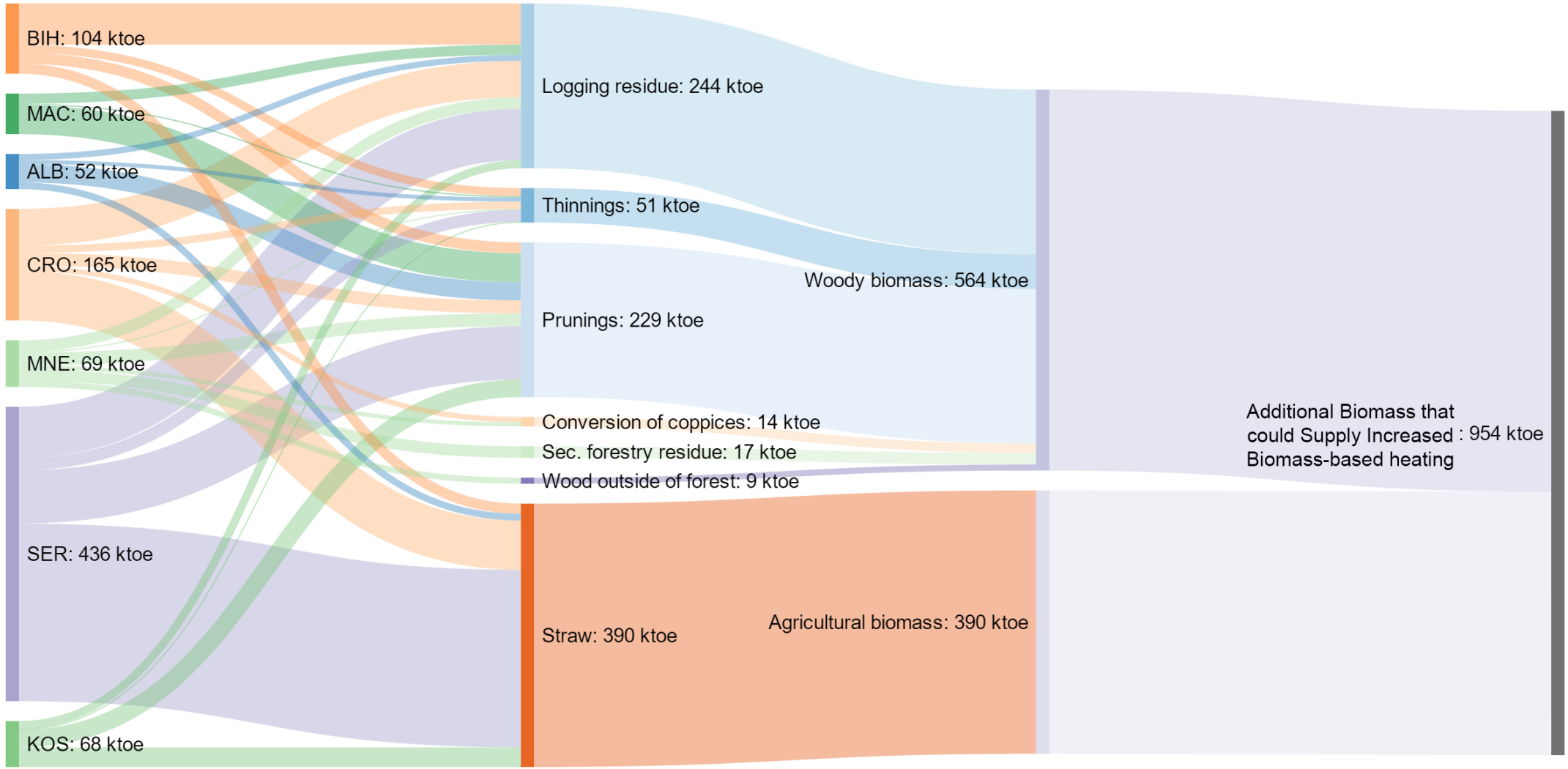
AVAILABLE BIOMASS TO SUPPLY INCREASED BIOMASS-BASED HEATING



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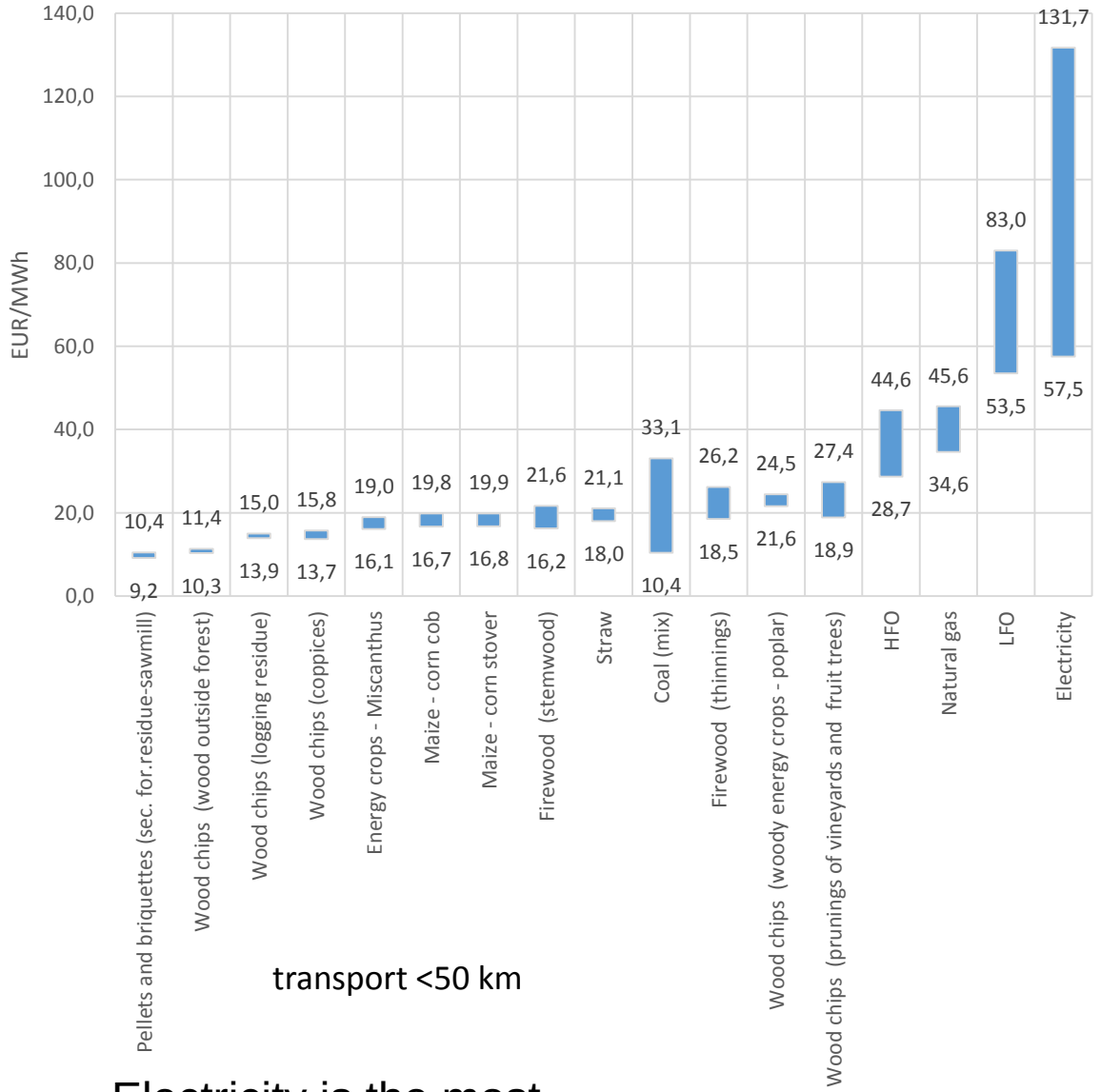
COSTS OF BIOMASS AND CONVENTIONAL FUELS FOR HEATING IN THE WESTERN BALKANS

Biomass feedstock	Costs of production	Harvesting/Collection	Forward extraction to forest road	Transport to the plant /warehouse	Cost of reconstruction of forest roads	Biomass storage	Pre-treatment				Transport to the end-use location	Biomass fuel
							Splitting	Chipping	Pelleting	Baling		
Stemwood	+	+	+	+	+	+	+				+	Fire wood
Thinnings	+	+	+	+	+	+	+				+	Fire wood
Logging residue	+	+	+	+	+	+		+			+	Wood chips
Secondary forest residue	+			+		+			+		+	Wood pellets
From the reconstruction of coppices	+	+	+	+	+	+		+			+	Wood chips
From outside of forest	+	+	+	+	+	+		+			+	Wood chips
Forest energy crops - Poplar	+	+	+	+	+	+		+			+	Wood chips
Vineyard and fruit tree prunnings	+	+		+		+		+			+	Wood chips
Agricultural biomass	+	+		+		+				+	+	Bales
Agricultural energy crops - Miscanthus	+	+		+		+				+	+	Bales



transport <50 km

Electricity is the most expensive option for heating

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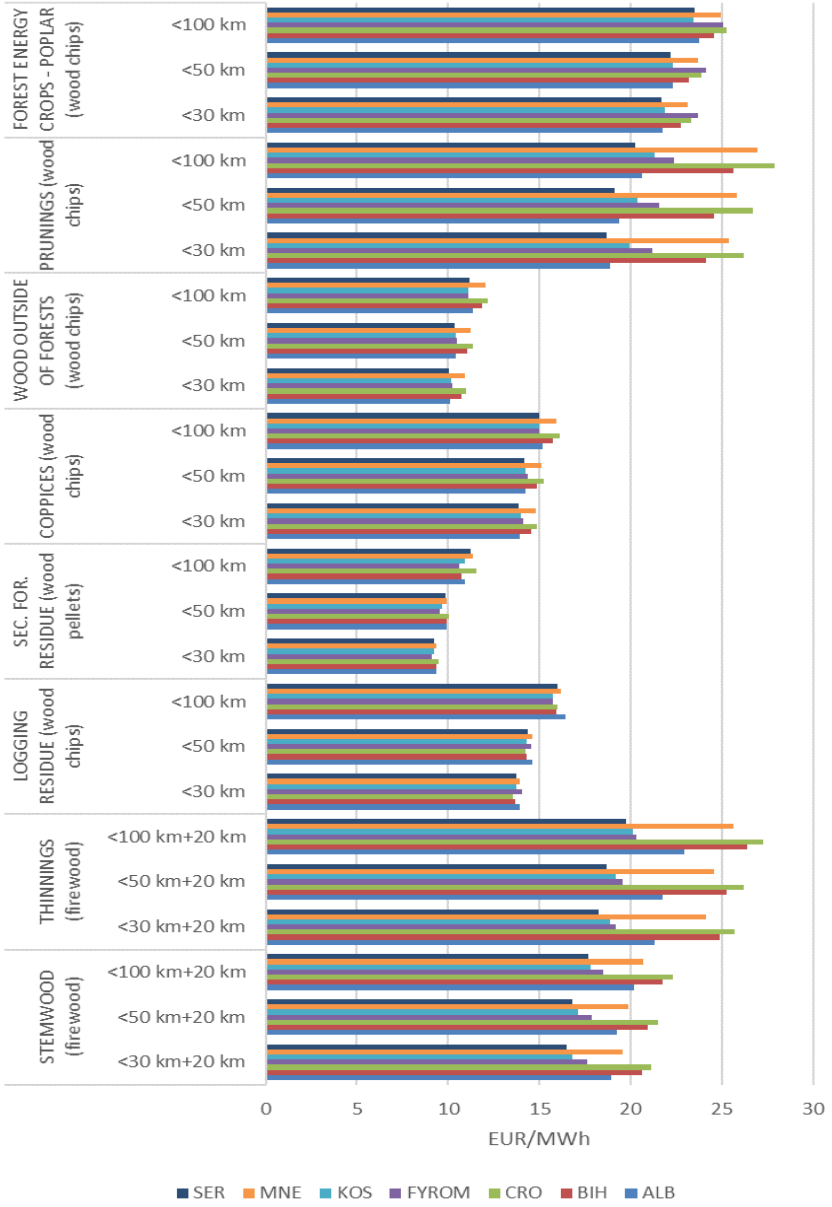
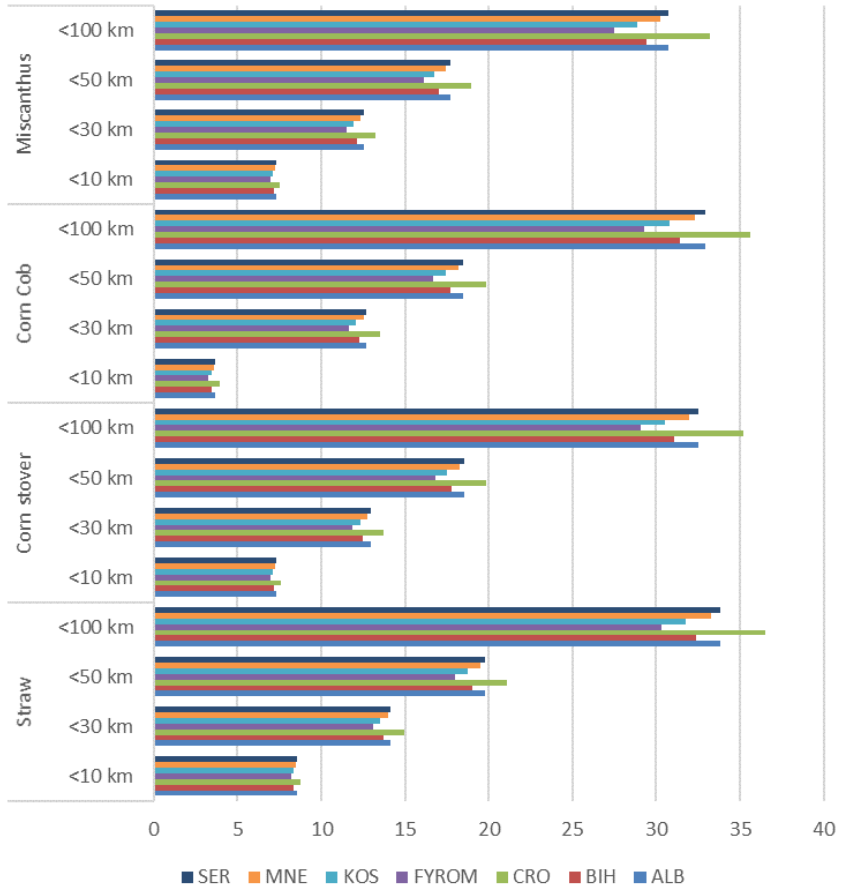
GATE FEE OF WOODY AND AGRICULTURAL BIOMASS IN THE WESTERN BALKANS

Firewood from stem-wood 40-80% more costly than wood chips





8.7-26.9 EUR/MWh <30 km
9.2-27.4 EUR/MWh <50 km
9.8-36.5 EUR/MWh <100 km

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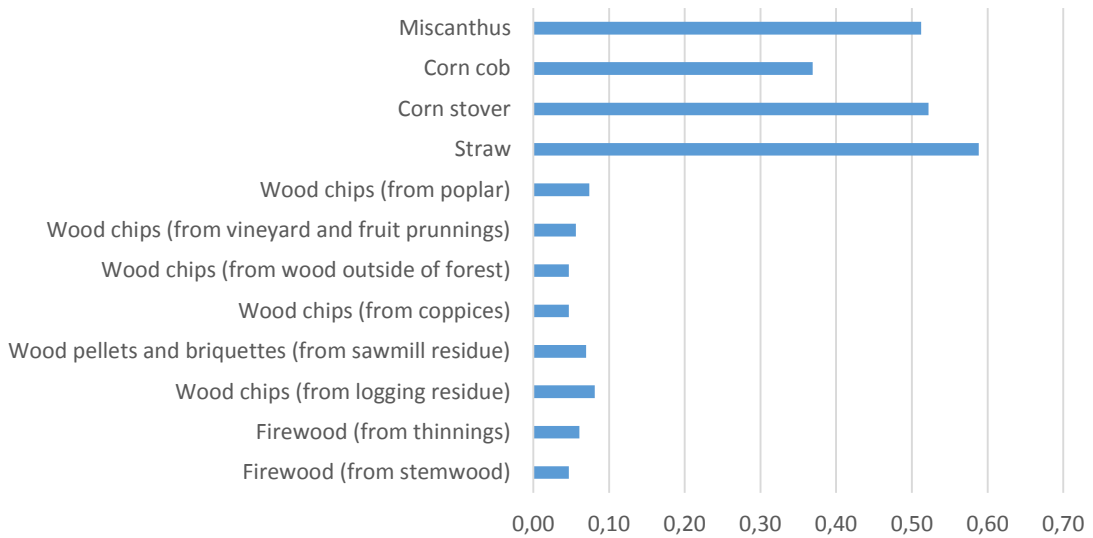
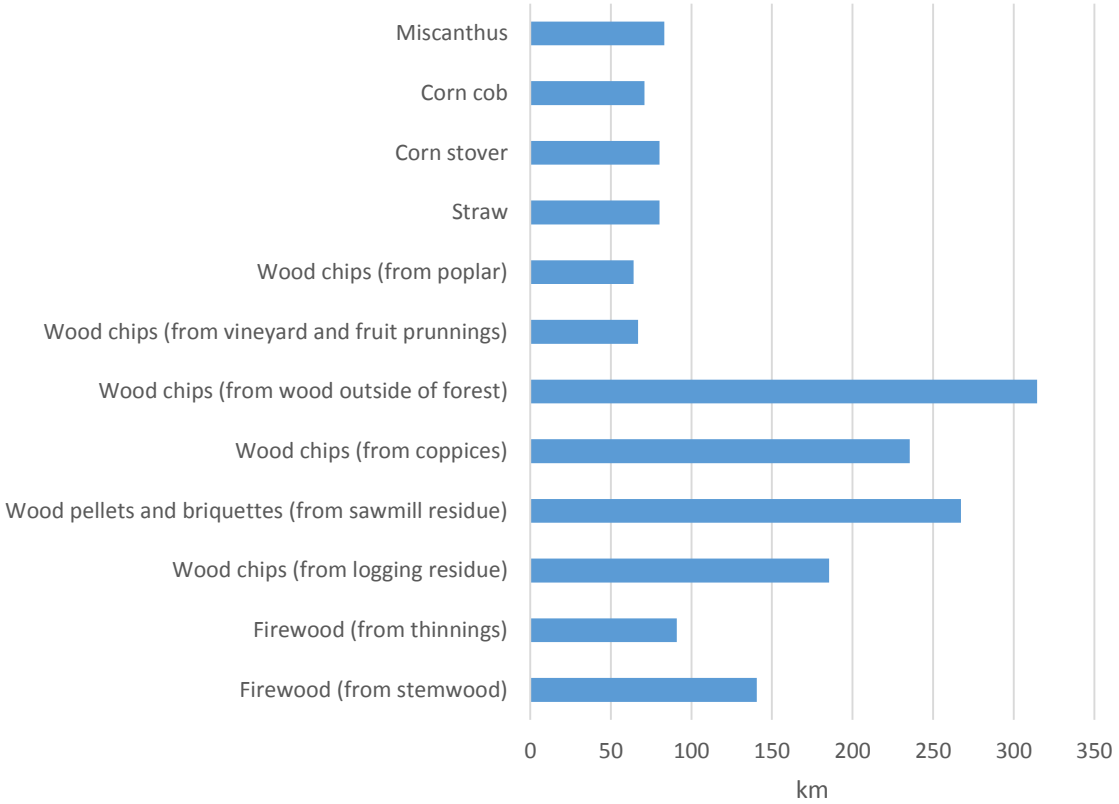
TRANSPORT OF BIOMASS

A key component to a viable biomass production / delivery system

Average costs of transport per 1 km, EUR/MWh



Recommended transport distance, in km



Cost of transportation of agricultural biomass 7-10 times higher compared to woody biomass

The cost of transport, storage and pre-treatment of biomass 50-95% of the total delivered cost of the fuel

Key requirement – to maximize energy density of biomass and gains in transport efficiency

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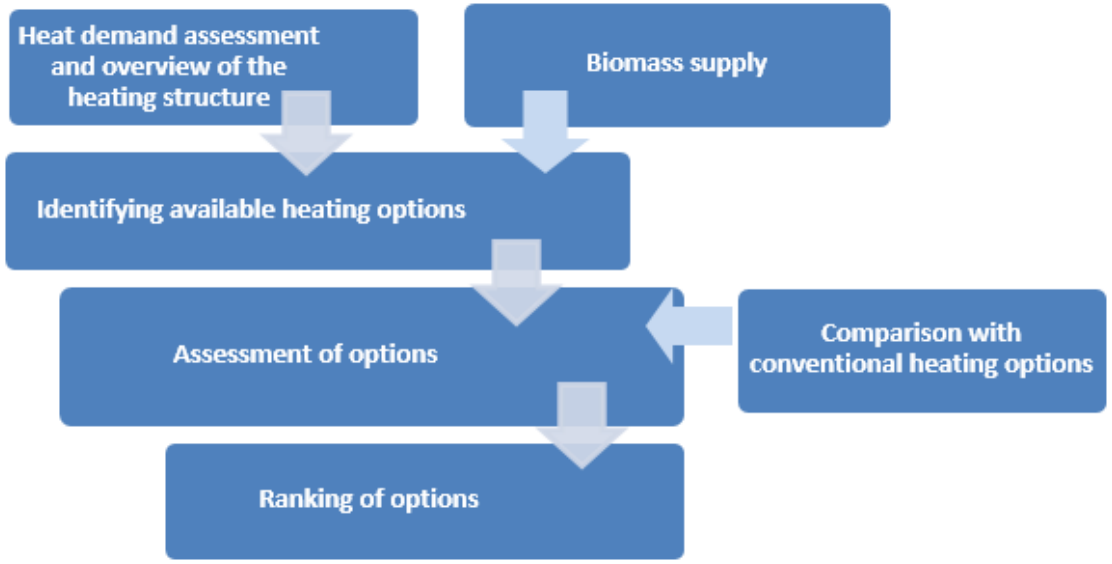
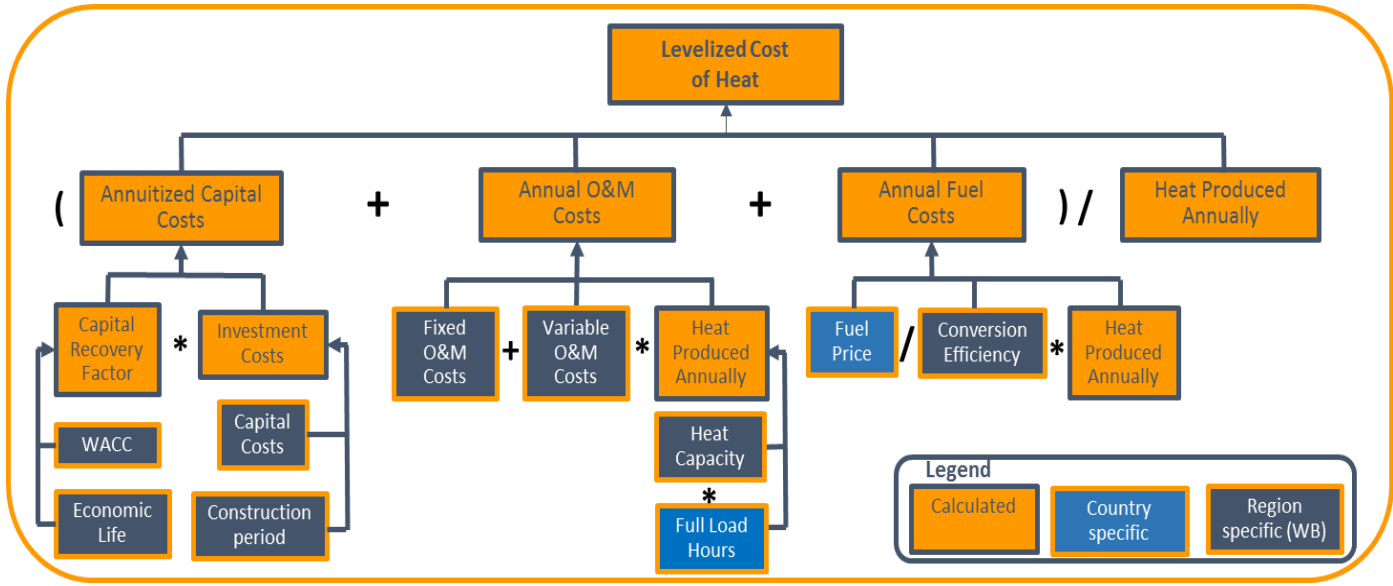
COST-EFFECTIVENESS OF BIOMASS HEATING OPTIONS





FINANCIAL VIABILITY

Private costs
- consumer perspective
- based on actual market prices
- VAT included
- cash flows discounted with a country specific WACC

ECONOMIC VIABILITY

Social costs
- private costs + the costs of externalities (GHG, air pollution)
- measures the costs and benefits of the biomass heating to the society
- VAT not included
- cash flows discounted with a 10% discount rate in all W-B countries

Multi-store buildings in BIH, CRO, KOS, MAC, SER – internal heating network in place
ALB, MNE – added costs of internal heating network

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ECONOMIC VIABILITY OF BIOMASS HEATING OPTIONS IN THE WESTERN BALKANS

Heating option	Coal	HFO/LFO	NG	Electricity	Heat Pumps	Firewood Inefficient Stove
New DH HOBs						
Wood chips	🔴	🟢	🟢			
Straw	🔴	🟢	🟢			
New CHPs						
Wood chips			🔴			
Straw			🔴			
Retrofitting DH HOBs (Fuel Conversion)						
Wood Chips	🔴	🟢	🟢			
Straw	🟡	🟢	🟢			
New Small HOBs						
Wood chips	🟢	🟢	🟢	🟢		
Pellets	🔴	🟢	🟢	🟢		
Retrofitting Small HOBs						
Wood chips	🟢	🟢	🟢			
Pellets	🔴	🟢	🔴			
New Individual Heating						
Firewood (Efficient Stove)	🟢		🟢	🟢	🟢	🟢
Pellets	🟢		🟢	🟢	🟡	🟢

LEGEND

- 🟢 Biomass heating more cost-effective than conventional
- 🔴 Biomass heating less cost-effective than conventional
- 🟡 Biomass heating similar in cost-effectiveness as conventional

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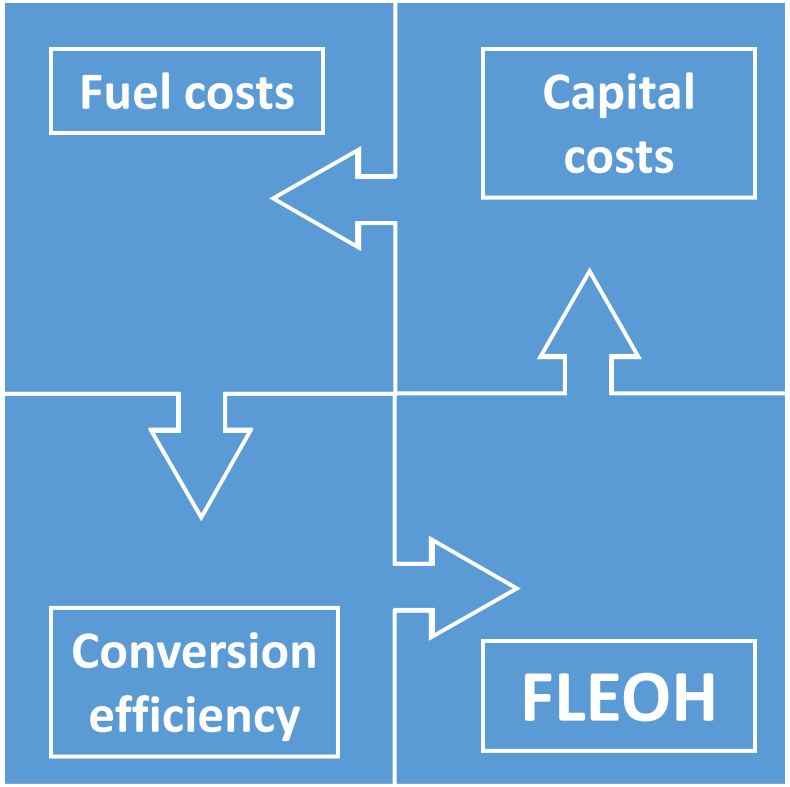
KEY FACTORS THAT IMPACT VIABILITY OF BIOMASS HEATING

Fuel Costs

Expected increase in prices of fossil fuels and electricity make biomass heating more attractive

Conversion efficiencies

Efficiency of fuel utilization significantly impact the total costs of heating



Capital costs

One of the main disadvantages of biomass heating options is the higher capital cost

Could be decreased with the greater involvement of local suppliers

Full load equivalent operating hours (FLEOH)

If low - lead to higher capital and O&M costs per unit of heat produced

FINANCIAL VIABILITY OF BIOMASS HEATING OPTIONS

Stand-alone buildings

	ALB	BIH	CRO	KOS	MK	MNE	SER
Individual electric appliance - replacement w/ efficient firewood stove	74%	54%	65%	45%	55%	62%	40%
Inefficient firewood stove - replacement with efficient firewood stove	51%	53%	53%	53%	53%	53%	53%
LFO small HOB - conversion to wood chips	61%	56%	60%	54%	49%	57%	62%
LPG small HOB - conversion to wood chips	31%	-	47%	58%	-	-	-
Coal stove - replacement with efficient firewood stove	-	-19%	-	-	-	-	15%
Coal small HOB - conversion to wood chips	-	-32%	-	-	-	-	2%
NG small HOB - conversion to wood chips	-	-	21%	-	8%	-	28%
NG stove - replacement with efficient firewood stove	-	-	-	-	-	-	34%

Multi-store buildings

	ALB	BIH	CRO	KOS	MK	MNE	SER
Individual electric appliance - replacement with wood chips small HOB	52%	63%	77%	55%	67%	64%	53%
LPG small HOB - replacement with wood chips	49%	-	58%	66%	-	-	-
LFO small HOB - replacement with wood chips	70%	63%	66%	62%	56%	-	68%
Coal small HOB - conversion to wood chips	-	-7%	-	-	-	-37%	5%
NG small HOB - replacement with wood chips small HOB	-	63%	35%	-	-	-	40%
DH coal HOB - conversion to straw	-	-23%	-	-	-	-	4%
DH NG HOB - conversion to straw	-	-	23%	-	-	-	47%
DH NG HOB - conversion to wood chips	-	-	-	-	19%	-	-
DH HFO HOB - conversion to straw	-	-	27%	23%	-	-	41%

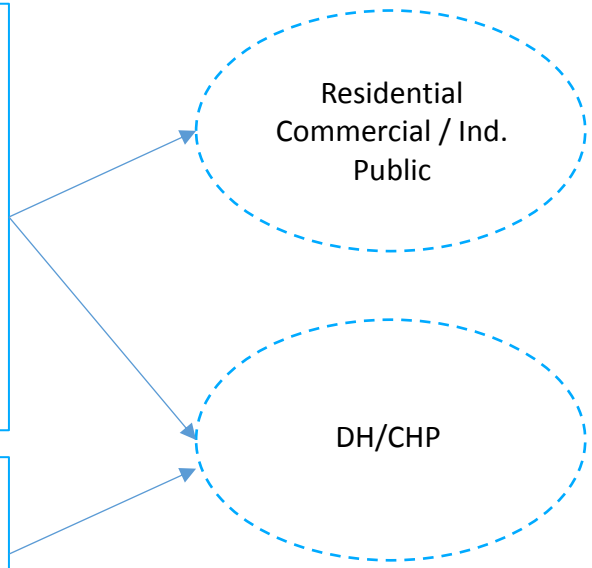
When economically viable biomass heating option is not financially viable, or expected gains are not attractive to final consumers - incentives should be provided as the benefits for the society overweight the costs of the introduction of biomass heating

- Replacement of coal stoves with efficient firewood stoves in stand-alone buildings in BIH and SER
- Conversion of coal small HOBs into wood chip small HOBs in stand-alone and multi-store buildings in BIH and SER, and multi-store buildings in MNE
- Conversion of coal DH HOBs into straw DH HOBs in BIH and SER

ECONOMIC POTENTIAL TO INCREASE THE USE OF BIOMASS FOR HEATING IN THE WESTERN BALKANS

Woody biomass residues
Logging residues
Prunings
Thinnings
Conversion of coppices
Sec. forestry residues
Wood outside of forests

Agricultural residues
Straw from small grain cereals and oil crops



The vast economic potential calls for increased, programmatic efforts to promote and finance:

- Efficient biomass stoves
- Replacement of electric with biomass heating in the residential buildings
- Fuel switch to biomass in District Heating plants

Installed heating capacity (MW) that could be economically supplied	ALB	BIH	CRO	FYROM	KOS	MNE	SER	W-B
-with woody biomass	224	380	361	240	126	266	551	2,148
-with agricultural biomass	63	64	290	-	107	-	839	1,363

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ECONOMIC POTENTIAL TO INCREASE THE USE OF BIOMASS FOR HEATING IN THE WESTERN BALKANS

Potential for Programmatic Approach to Promote Efficient Biomass Stoves in the Western Balkans

(assuming replacement of 10% of heat demand from inefficient wood stoves with efficient ones over a 10 year period)

	Annual replacement of inefficient stoves (ktoe)	Annually required efficient biomass appliances for replacement (MW)	Annual cost of replacement (M EUR)	Average annual fuel savings (ktoe)	Cumulative fuel savings for heating (2017-2026), ktoe
ALB	13	99	5.1	7	67
BIH	35	218	11.3	19	187
CRO	7	42	2.1	4	38
FYROM	19	111	5.7	10	101
KOS	32	147	7.7	17	170
MNE	6	36	1.9	3	34
SER	25	117	6	13	133
W-B	137	770	40	73	731

ECONOMIC POTENTIAL TO INCREASE THE USE OF BIOMASS FOR HEATING IN THE WESTERN BALKANS

Potential for Programmatic Approach to Promote Increased Use of Biomass Heating in the Western Balkans

Replacement of electric with biomass heating in the residential buildings in Western Balkans

	ALB	BIH	CRO	FYROM	KOS	MNE	SER	W-B
Efficient firewood stoves (stand-alone buildings) - MW	0	39	0	0	0	175	313	527
Wood chips small HOBs (multi-store buildings) - MW	224	342	361	240	126	91	238	1,622
Share of electric heating replaced with biomass heating (%)	8%	48%	21%	19%	20%	89%	81%	28%
Share of total heat demand replaced with biomass heating (%)	5%	4%	5%	8%	4%	28%	9%	6%

Fuel switch to biomass in District Heating plants in Western Balkans

	ALB	BIH	CRO	FYROM	KOS	MNE	SER	W-B
Fuel switch to straw or wood chips in DH HOB coal (MW)	0	64	0	0	0	0	579	643
Fuel switch to straw or wood chips in DH HOB HFO (MW)	0	0	73	0	6	0	123	202
Fuel switch to straw or wood chips in DH HOB NG (MW)	0	0	217	0	0	0	137	354
New DH HOB using straw or wood chips (MW)	0	0	0	0	101	0	0	101
Share of fossil fuels DH replaced with biomass DH (%)	0%	5%	17%	0%	100%	0%	50%	29%
Share of total heat demand replaced with biomass heating (%)	0%	1%	2%	0%	3%	0%	11%	4%

ECONOMIC POTENTIAL TO INCREASE THE USE OF BIOMASS FOR HEATING IN THE WESTERN BALKANS

Overview of the investments

ESTIMATED INVESTMENTS (EUR)	ALB	BIH	CRO	FYROM	KOS	MNE	SER	W-B
Replacement of inefficient firewood stoves (Program for efficient biomass stoves)	51	113	21	57	77	19	60	399
Replacement of electric heating in stand-alone buildings with efficient firewood stoves	0	1	0	0	0	6	11	19
Replacement of electric heating in multi-store buildings with wood chips small HOBs	22	34	36	24	13	9	24	162
Retrofitting of DH HOB coal to straw/wood chips	0	16	0	0	0	0	142	158
Retrofitting of DH HOB HFO to straw/wood chips	0	0	21	0	2	0	36	59
Retrofitting of DH HOB NG to straw/wood chips	0	0	64	0	0	0	40	104
Construction of new DH HOB straw/wood chips	0	0	0	0	49	0	0	49
TOTAL	**74**	**164**	**143**	**81**	**140**	**34**	**314**	**950**

	ALB	BIH	CRO	FYROM	KOS	MNE	SER	W-B
Share of total heat demand replaced with biomass heating	5%	5%	7%	8%	7%	28%	20%	10%

ECONOMIC POTENTIAL TO INCREASE THE USE OF BIOMASS FOR IN THE WESTERN BALKANS

Reduction of CO_2 eq emissions

Avoided emissions (ton)	ALB	BIH	CRO	FYROM	KOS	MNE	SER	W-B
Replacement of inefficient firewood stoves (Program for efficient biomass stoves and boilers)	14,026	39,147	7,955	21,143	35,588	7,118	27,842	152,818
Replacement of electric heating in stand-alone buildings with efficient firewood stoves	0	86,297	0	0	0	218,015	939,093	1,243,404
Replacement of electric heating in multi-store buildings with wood chips small HOBs	283,449	762,591	345,741	640,524	554,278	113,367	713,960	3,413,909
Retrofitting of DH HOB coal to straw/wood chips	0	59,172	0	0	0	0	715,417	774,590
Retrofitting of DH HOB HFO to straw/wood chips	0	0	57,339	0	5,847	0	119,856	183,041
Retrofitting of DH HOB NG to straw/wood chips	0	0	128,312	0	0	0	100,519	228,831
Construction of new DH HOB straw/wood chips	0	0	0	0	124,378	0	0	124,378
TOTAL AVOIDED CO_2 eq EMISSIONS (ton)	**297,475**	**947,206**	**539,346**	**661,667**	**720,091**	**338,499**	**2,616,687**	**6,120,971**

THANK YOU FOR YOUR ATTENTION

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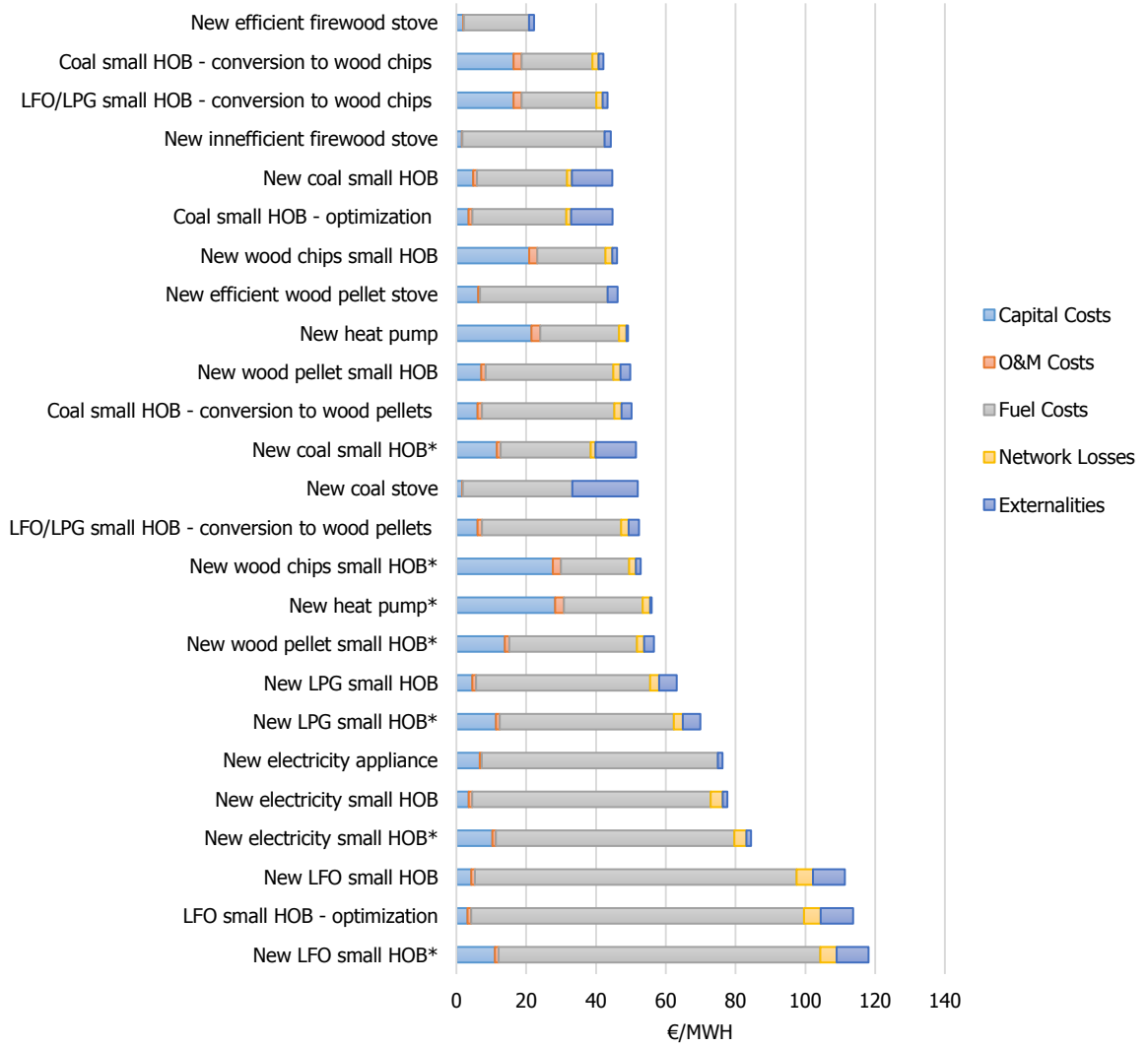
Key Heating Expert

Panagiotis GRAMMELIS
Key Heating Expert

Biljana CEPUJNOSKA
Key Energy Economist

ANNEX – ECONOMIC AND FINANCIAL VIABILITY OF HEATING OPTIONS - COUNTRY REPORTS

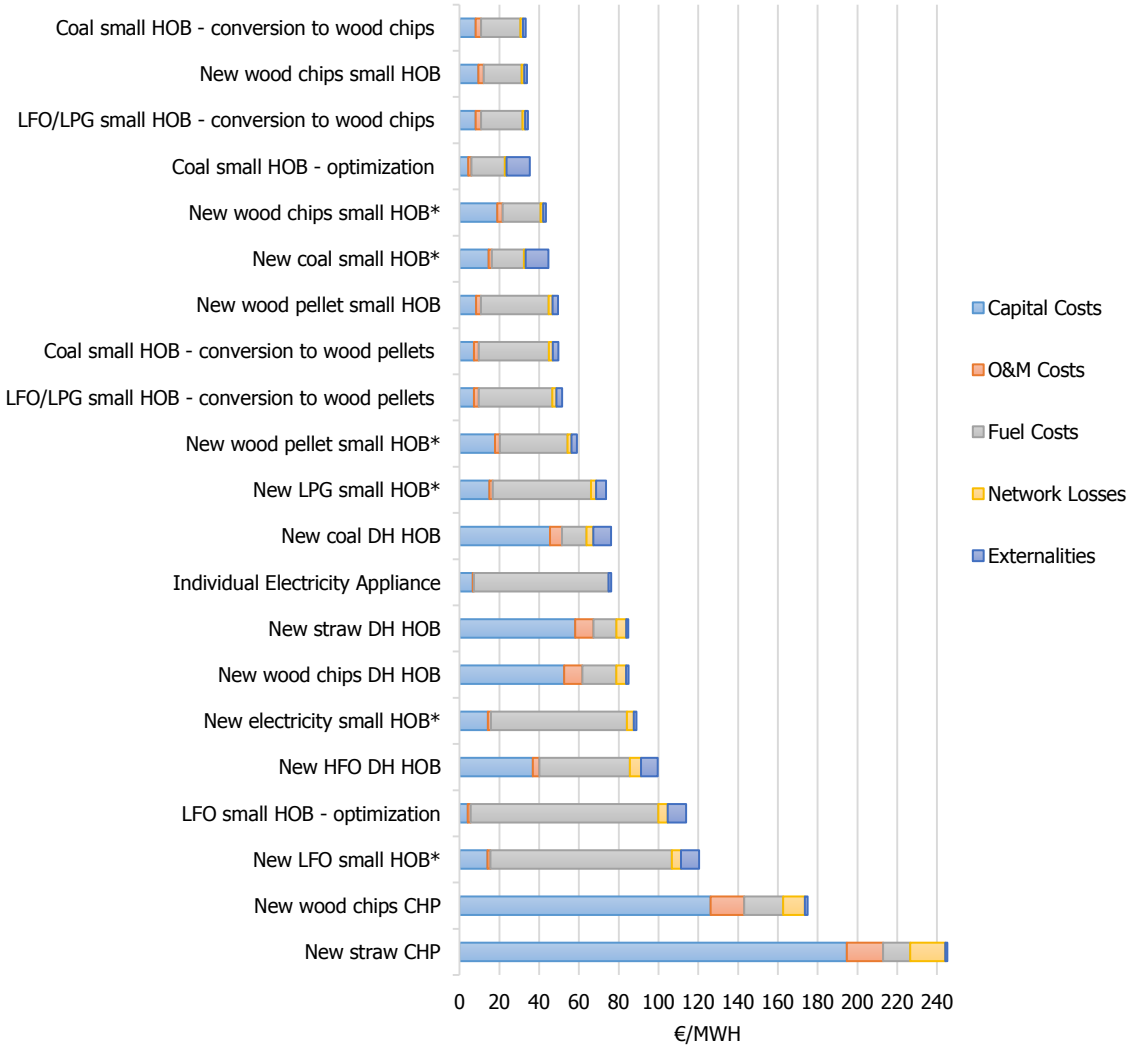
ALBANIA: Economic viability of heating options – stand-alone buildings



ALBANIA	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
STAND-ALONE BUILDINGS	Individual electric appliance	**New efficient firewood stove**	New efficient wood pellet stove New wood chips small HOB* New wood pellets small HOB*
	Inefficient wood stoves		-
	Small HOB-LFO	**LFO small HOB - conversion to wood chips**	New wood chips small HOB New wood pellets small HOB LFO small HOB - conversion to wood pellets
	Small HOB-LPG	**LPG small HOB - conversion to wood chips**	New wood chips small HOB New wood pellets small HOB LPG small HOB - conversion to wood pellets

*includes construction of new internal heating network

ALBANIA: Economic viability of heating options – multi-store buildings

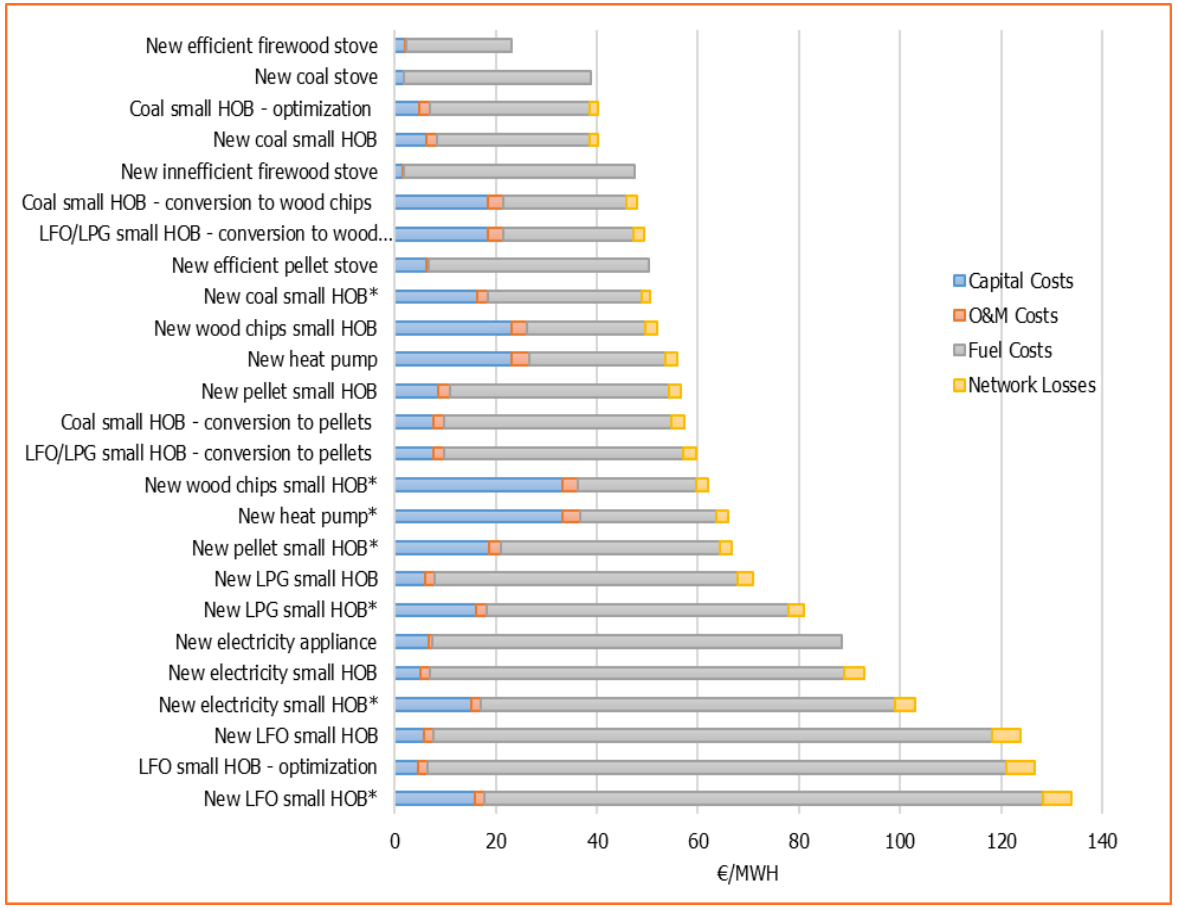


ALBANIA	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
MULTI-STORE BUILDINGS	Individual electric appliance	**New wood chips small HOB***	New wood pellets small HOB*
	Small HOB-LPG	**New wood chips small HOB**	LPG small HOB - conversion to wood chips New wood pellets small HOB LPG small HOB - conversion to wood pellets
	Small HOB-LFO		LFO small HOB - conversion to wood chips New wood pellets small HOB LFO small HOB - conversion to wood pellets New wood chips DH HOB

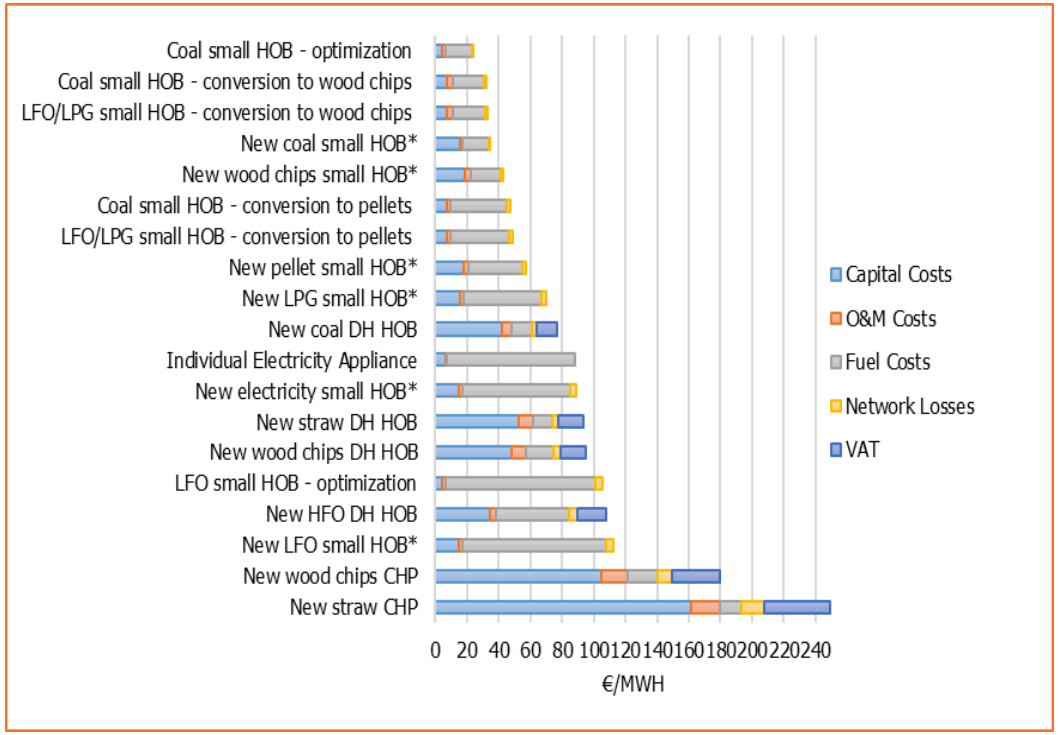
*includes construction of new internal heating network

ALBANIA: Financial viability of heating options

Stand-alone buildings



Multi-store buildings



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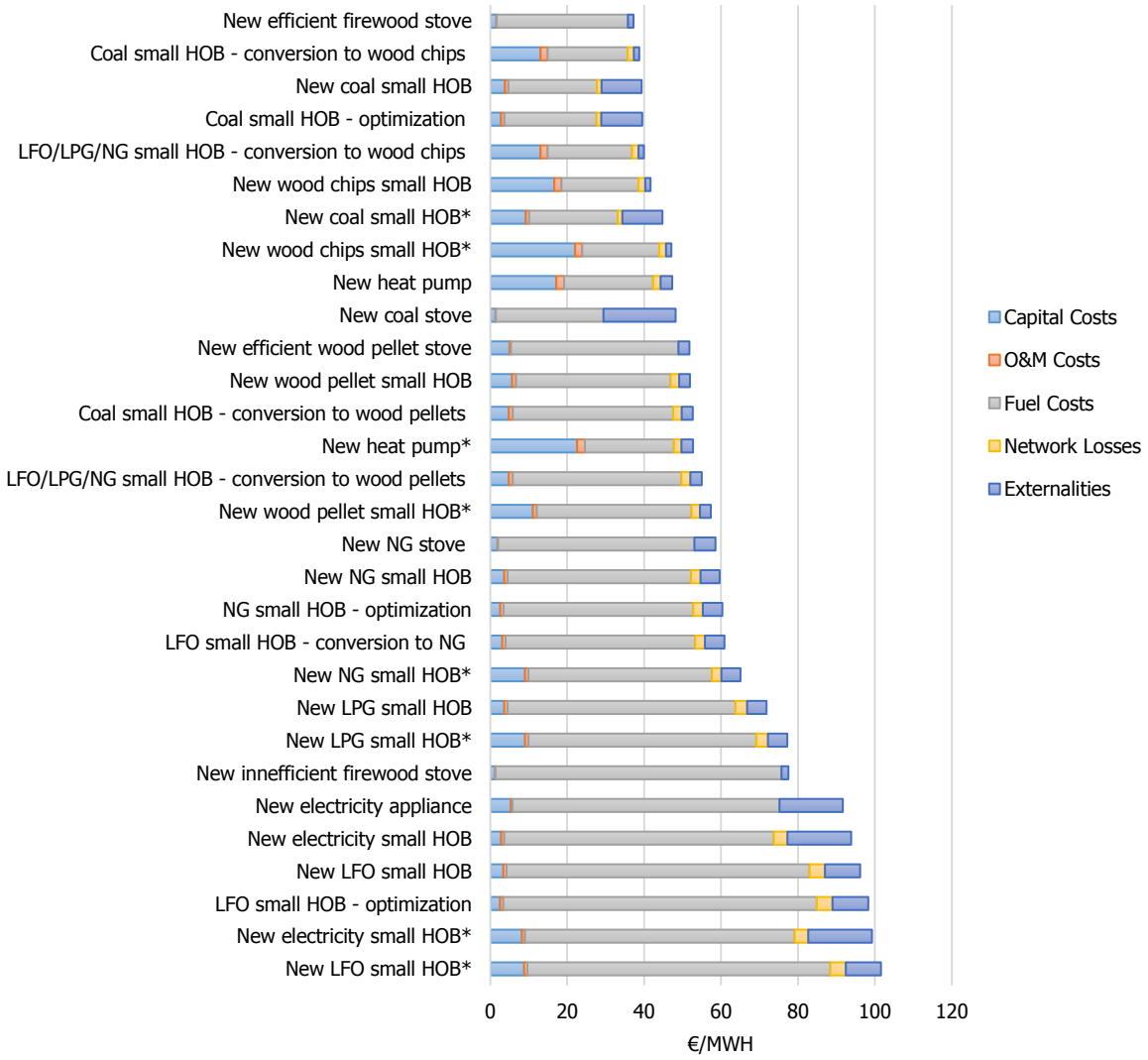
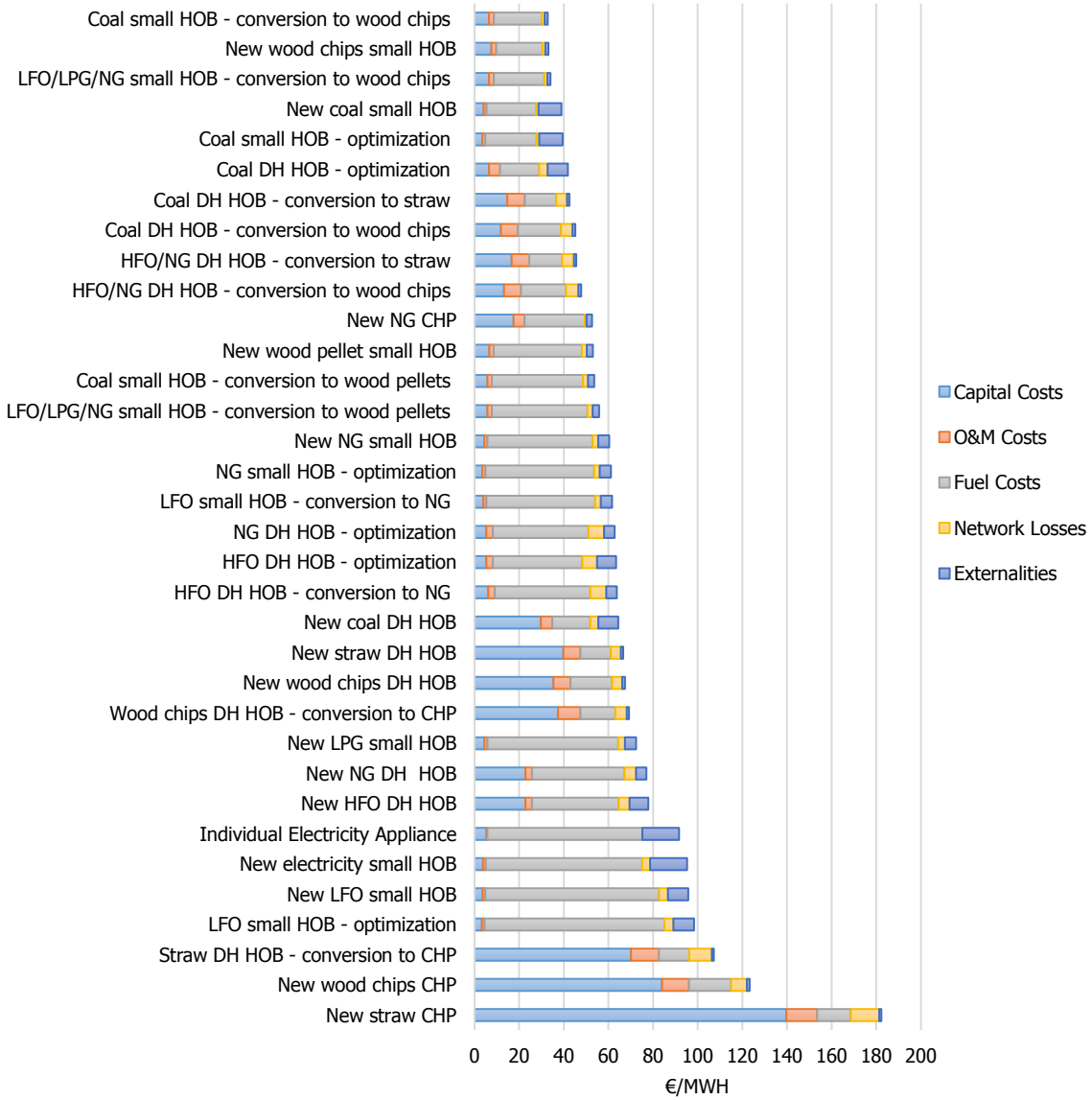
BOSNIA AND HERZEGOVINA: Economic viability of heating options – stand-alone buildings



BOSNIA AND HERZEGOVINA	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
STAND-ALONE BUILDINGS	Inefficient wood stoves	**New efficient firewood stove**	New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Individual electric appliance		New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Small HOB-LFO	**LFO small HOB - conversion to wood chips**	New wood chips small HOB LFO small HOB - conversion to wood pellets New wood pellets small HOB
	Coal stoves	**New efficient firewood stove**	New wood chips small HOB*
	Small HOB-coal	**Coal small HOB - conversion to wood chips**	-

*includes construction of new internal heating network

BOSNIA AND HERZEGOVINA : Economic viability of heating options – multi-store buildings

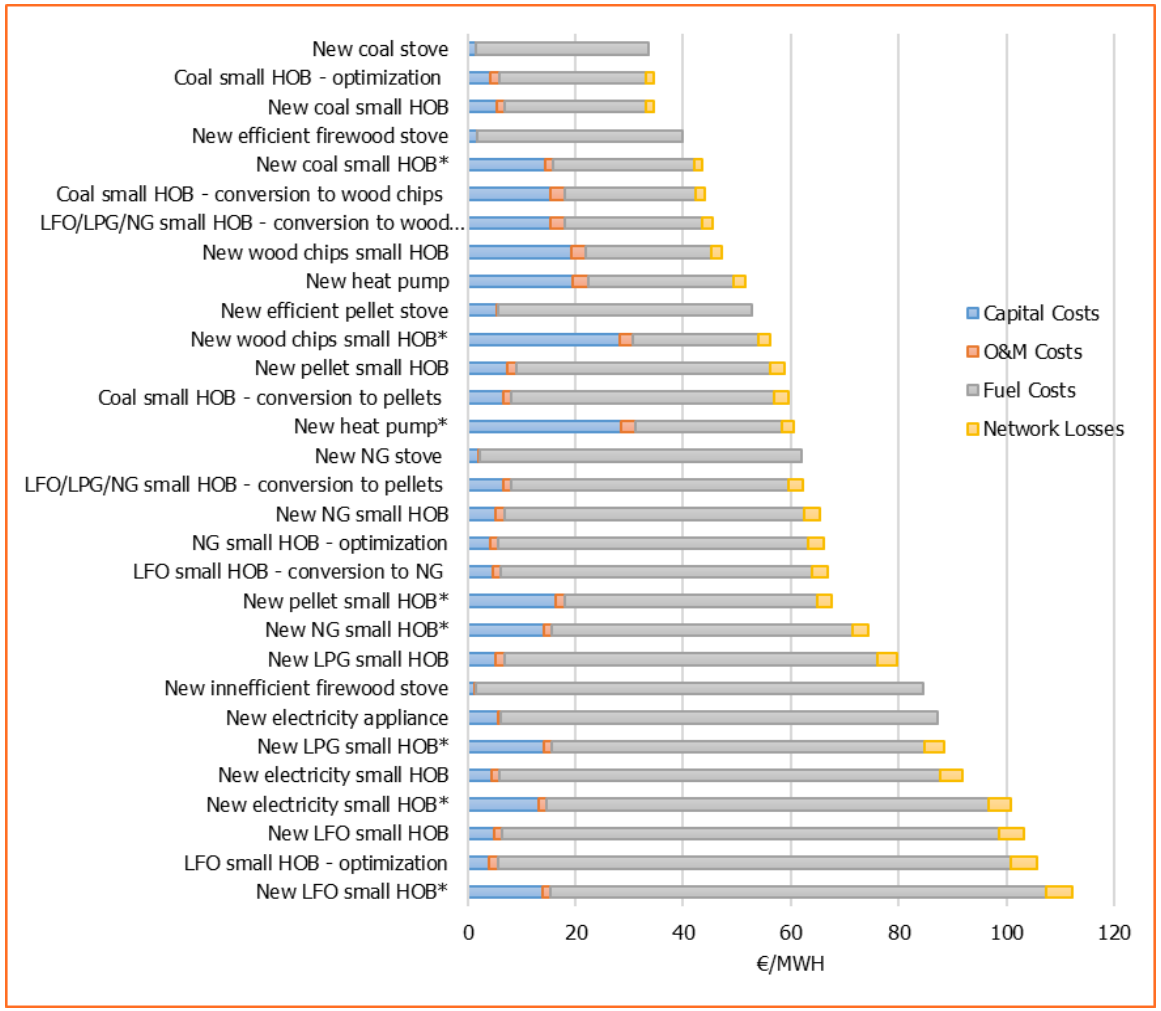


BOSNIA AND HERZEGOVINA	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
MULTI-STORE BUILDINGS	Small HOB-coal	**Coal small HOB - conversion to wood chips**	New wood chips small HOB
	Individual electric appliance	**New wood chips small HOB**	New wood pellets small HOB New straw DH HOB New wood chips DH HOB
	Small HOB-LFO		LFO small HOB - conversion to wood chips New wood pellets small HOB LFO small HOB - conversion to wood pellets New straw DH HOB New wood chips DH HOB
	Small HOB-NG		NG small HOB - conversion to wood chips New wood pellets small HOB NG small HOB - conversion to wood pellets
DH / CHP	DH HOB-coal	**Coal DH HOB - conversion to straw**	Coal DH HOB - conversion to wood chips

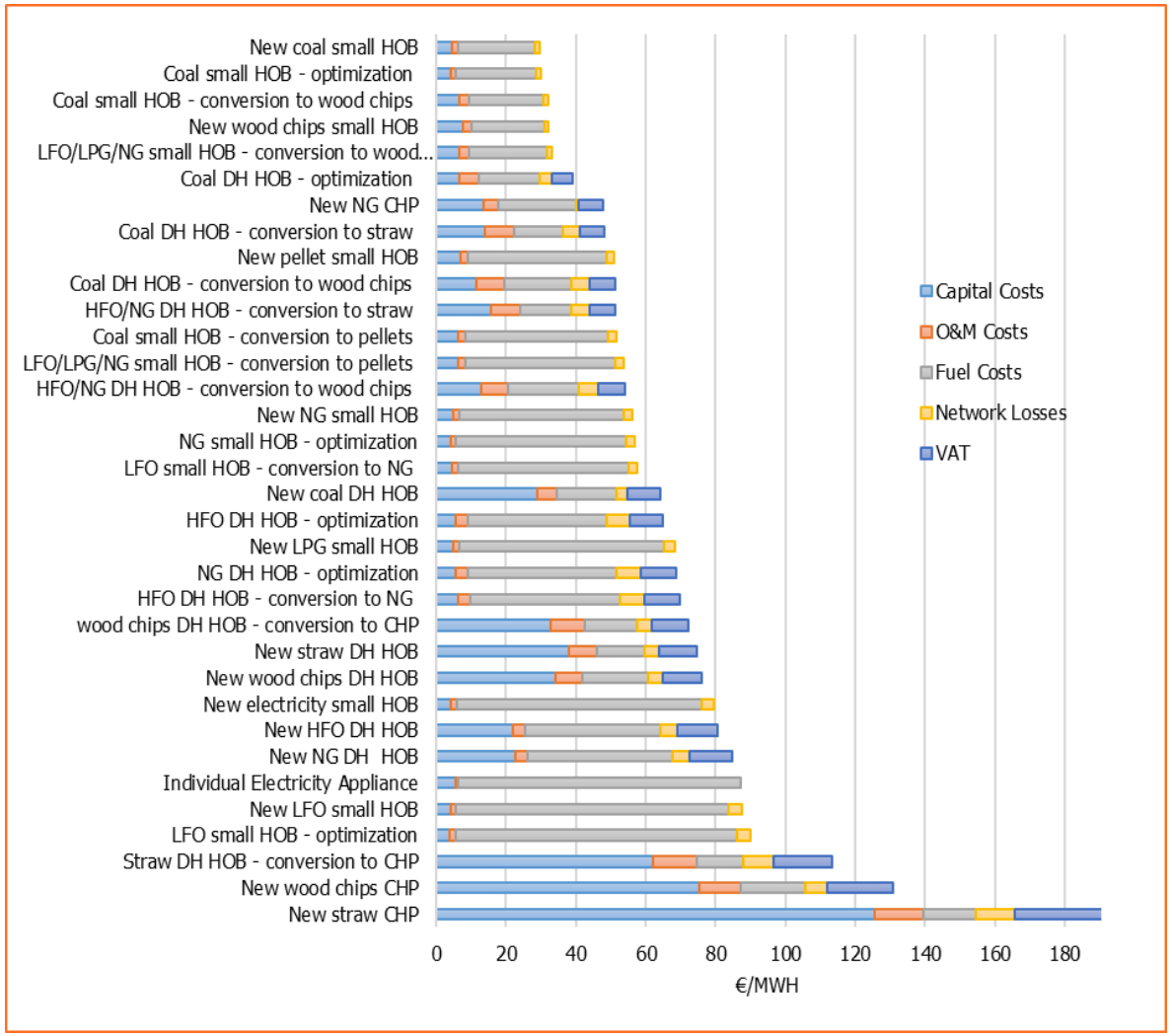
*includes construction of new internal heating network

BOSNIA AND HERZEGOVINA: Financial viability of heating options

Stand-alone buildings



Multi-store buildings



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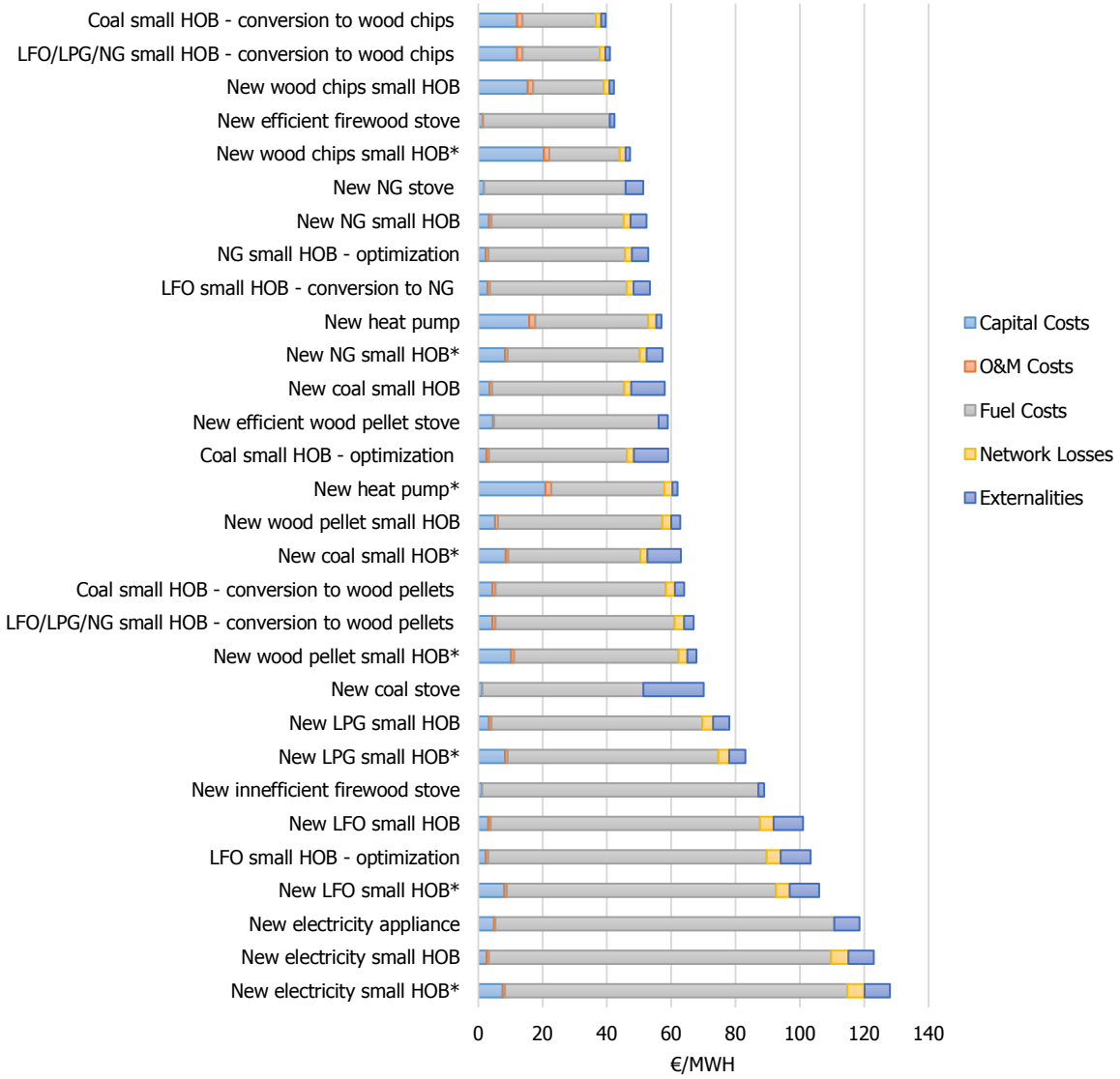
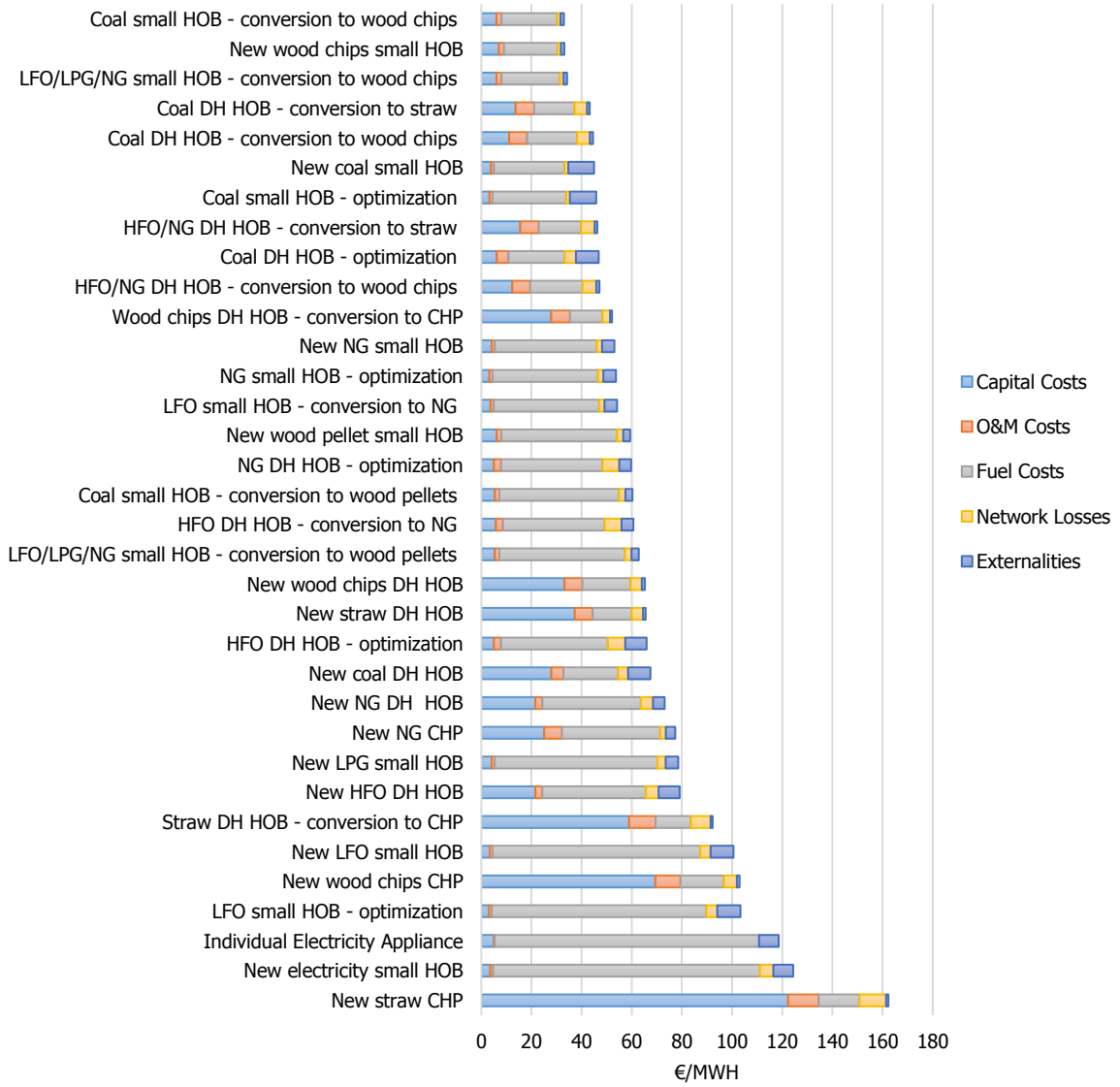
CROATIA: Economic viability of heating options – stand-alone buildings



CROATIA	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
STAND-ALONE BUILDINGS	Individual electric appliance	**New efficient firewood stove**	New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Small HOB-NG	**NG small HOB - conversion to wood chips**	New wood chips small HOB
	Inefficient wood stoves	**New efficient firewood stove**	New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Small HOB-LFO	**LFO small HOB - conversion to wood chips**	New wood chips small HOB New wood pellets small HOB
	Small HOB-LPG	**LPG small HOB - conversion to wood chips**	New wood chips small HOB New wood pellets small HOB

*includes construction of new internal heating network

CROATIA: Economic viability of heating options – multi-store buildings

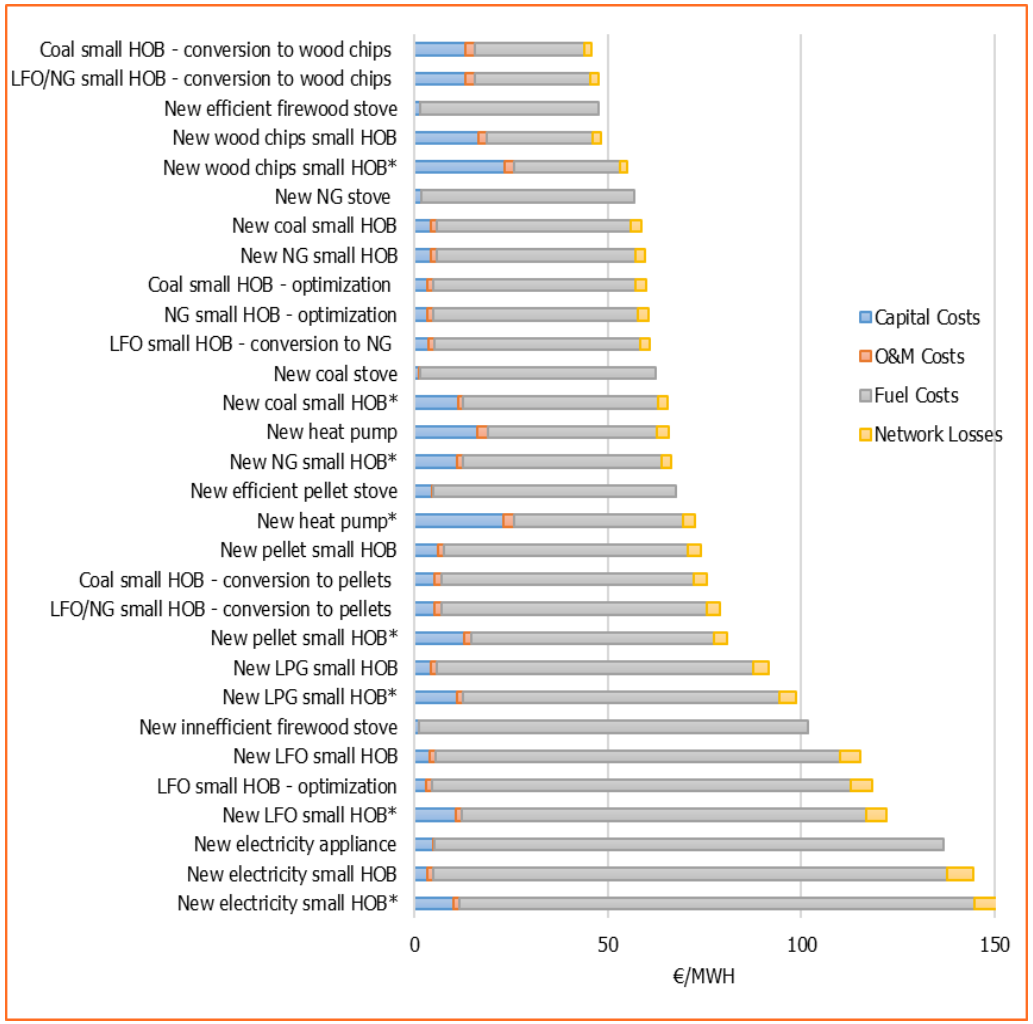


CROATIA	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
MULTI-STORE BUILDINGS	Small HOB-NG	**New wood chips small HOB**	NG small HOB - conversion to wood chips
	Individual electric appliance		New wood pellets small HOB New wood chips DH HOB New straw DH HOB New wood chips CHP
	Small HOB-LFO		LFO small HOB - conversion to wood chips New wood pellets small HOB New wood chips DH HOB New straw DH HOB
	Small HOB-LPG		LFO small HOB - conversion to wood chips New wood pellets small HOB New wood chips DH HOB New straw DH HOB
DH / CHP	DH HOB-NG	**NG DH HOB - conversion to straw**	NG DH HOB - conversion to wood chips New wood chips DH HOB New straw DH HOB
	DH HOB-HFO	**HFO DH HOB - conversion to straw**	HFO DH HOB - conversion to wood chips New wood chips DH HOB New straw DH HOB

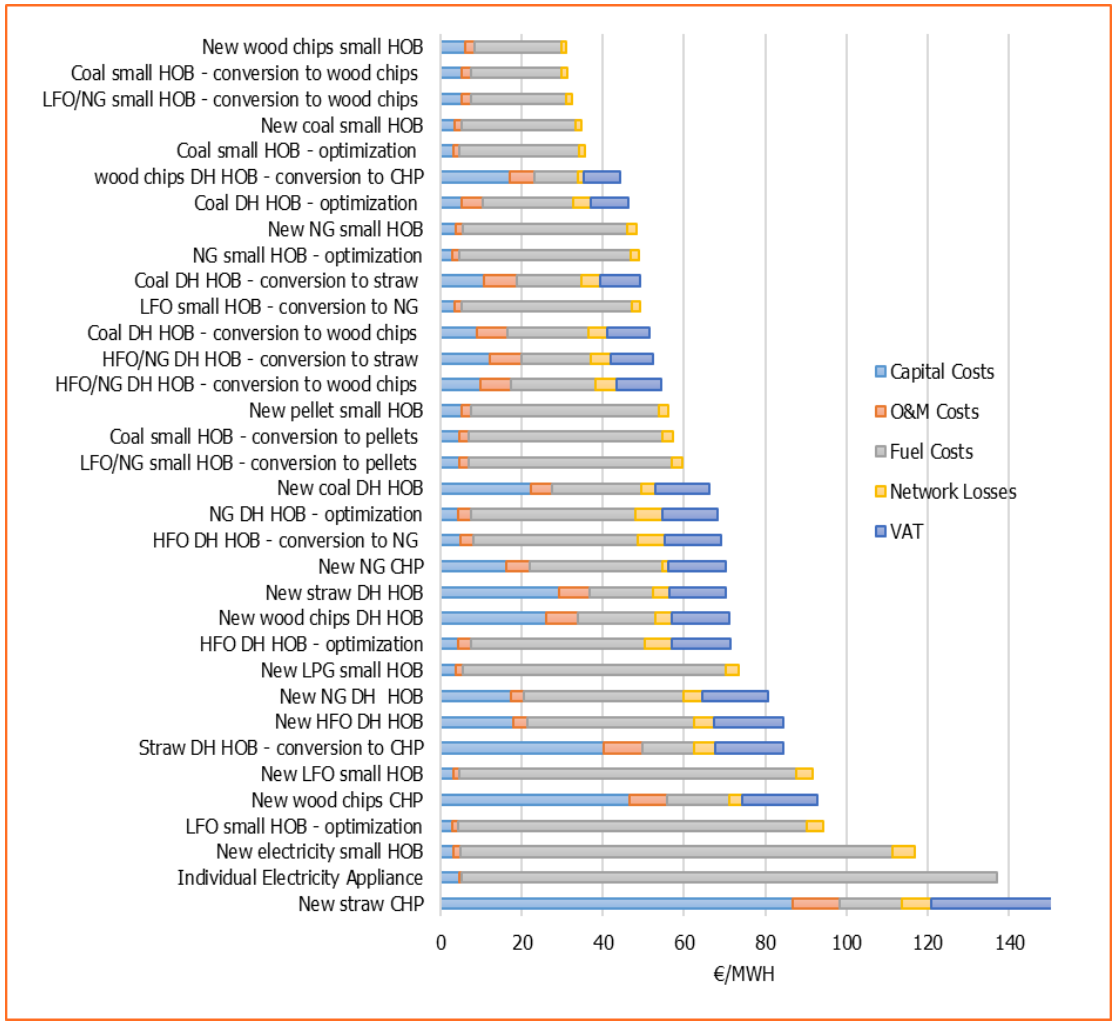
*includes construction of new internal heating network

CROATIA: Financial viability of heating options

Stand-alone buildings



Multi-store buildings



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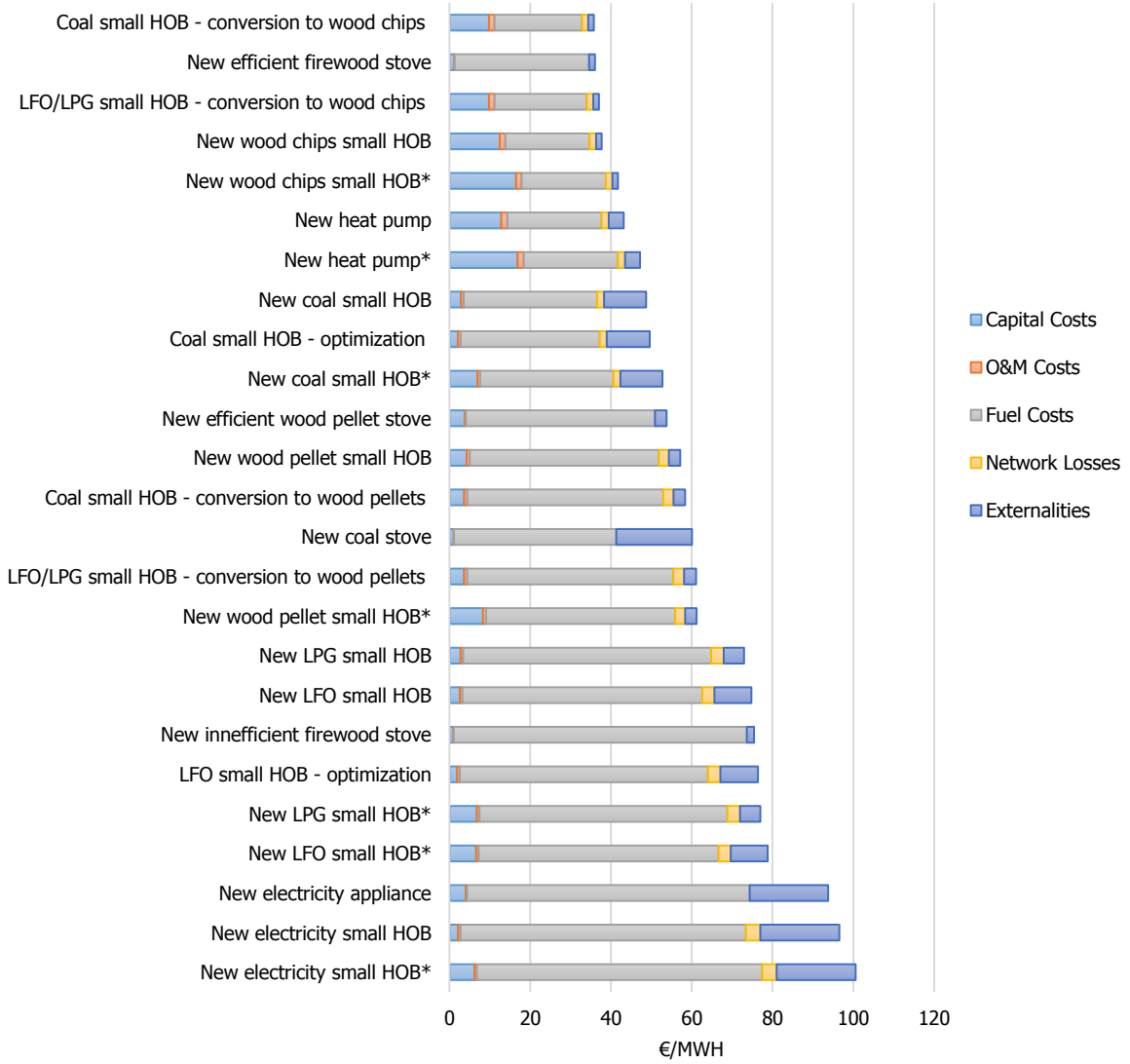
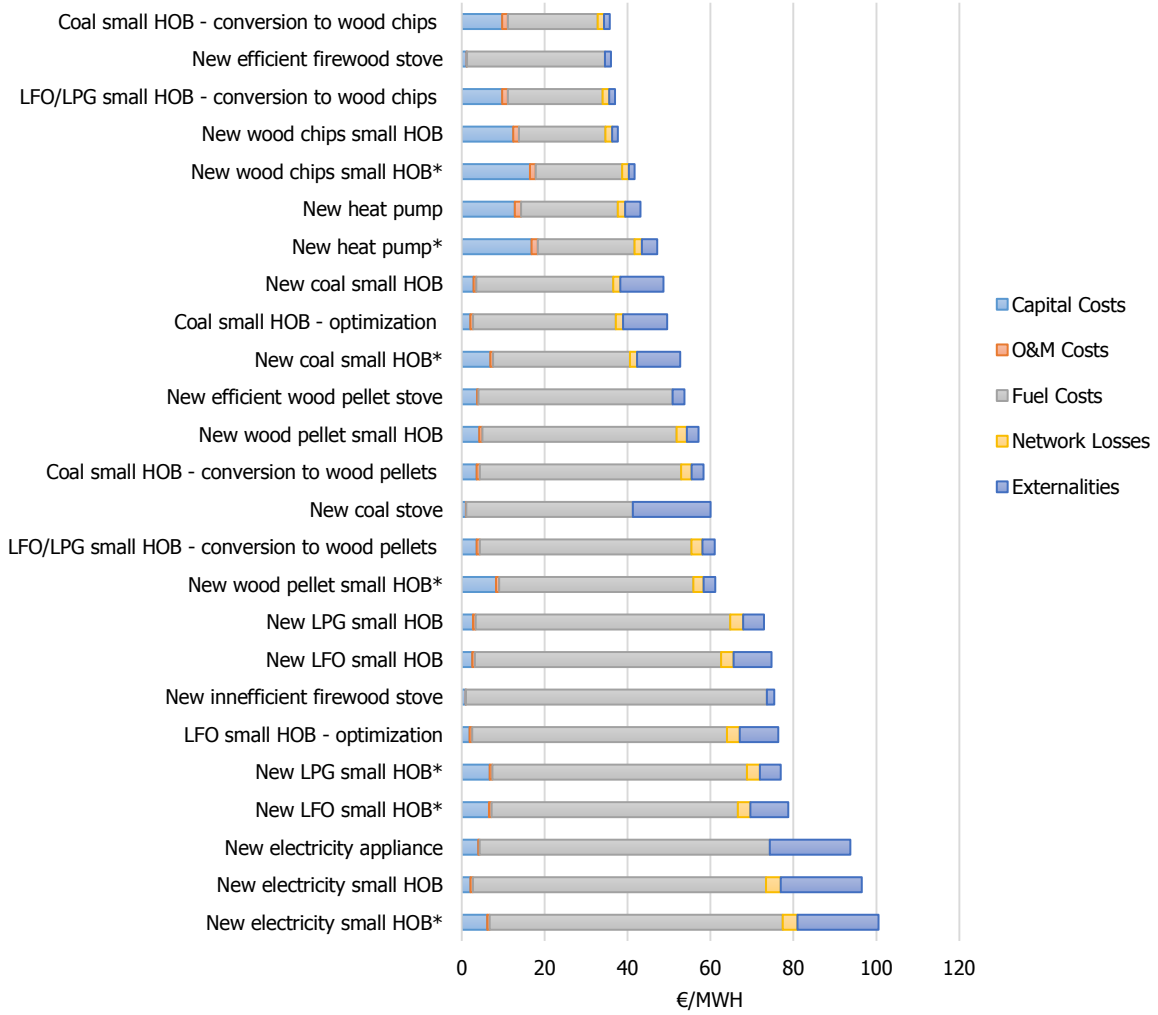
FYR OF MACEDONIA: Economic viability of heating options – stand-alone buildings



FYR OF MACEDONIA	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
STAND-ALONE BUILDINGS	Inefficient wood stoves	**New efficient firewood stove**	New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Individual electric appliance		New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Small HOB-LFO	**LFO small HOB - conversion to wood chips**	New wood chips small HOB New wood pellets small HOB LFO small HOB - conversion to wood pellets
	Small HOB-NG	**NG small HOB – conversion to wood chips**	New wood chips small HOB

*includes construction of new internal heating network

FYR OF MACEDONIA : Economic viability of heating options – multi-store buildings

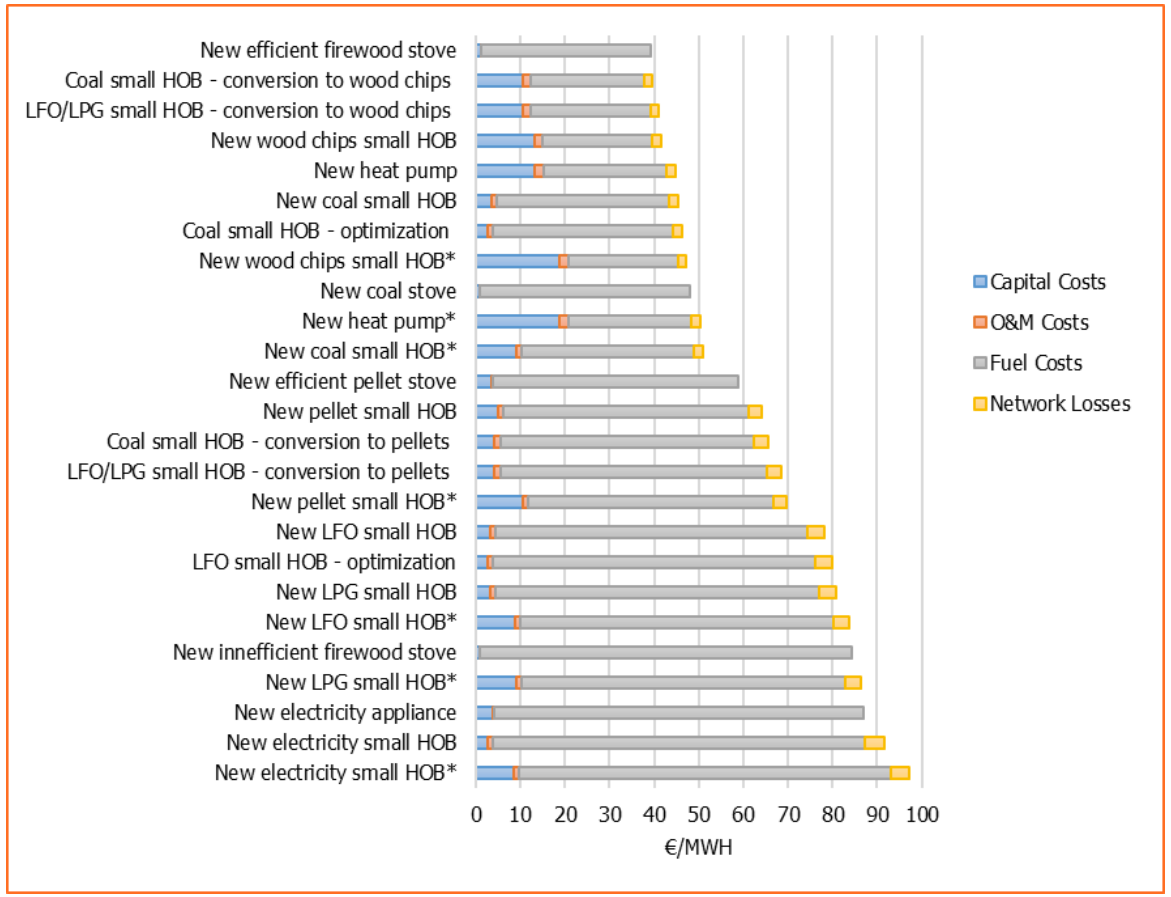


FYR OF MACEDONIA	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
MULTI-STORE BUILDINGS	Individual electric appliance	**New wood chips small HOB**	New wood pellets small HOB New wood chips DH HOB New wood chips CHP
	Small HOB-LFO		LFO small HOB - conversion to wood chips New wood pellets small HOB New wood chips DH HOB LFO small HOB - conversion to wood pellets
DH / CHP	DH HOB-NG	**NG DH HOB - conversion to wood chips**	New wood chips DH HOB

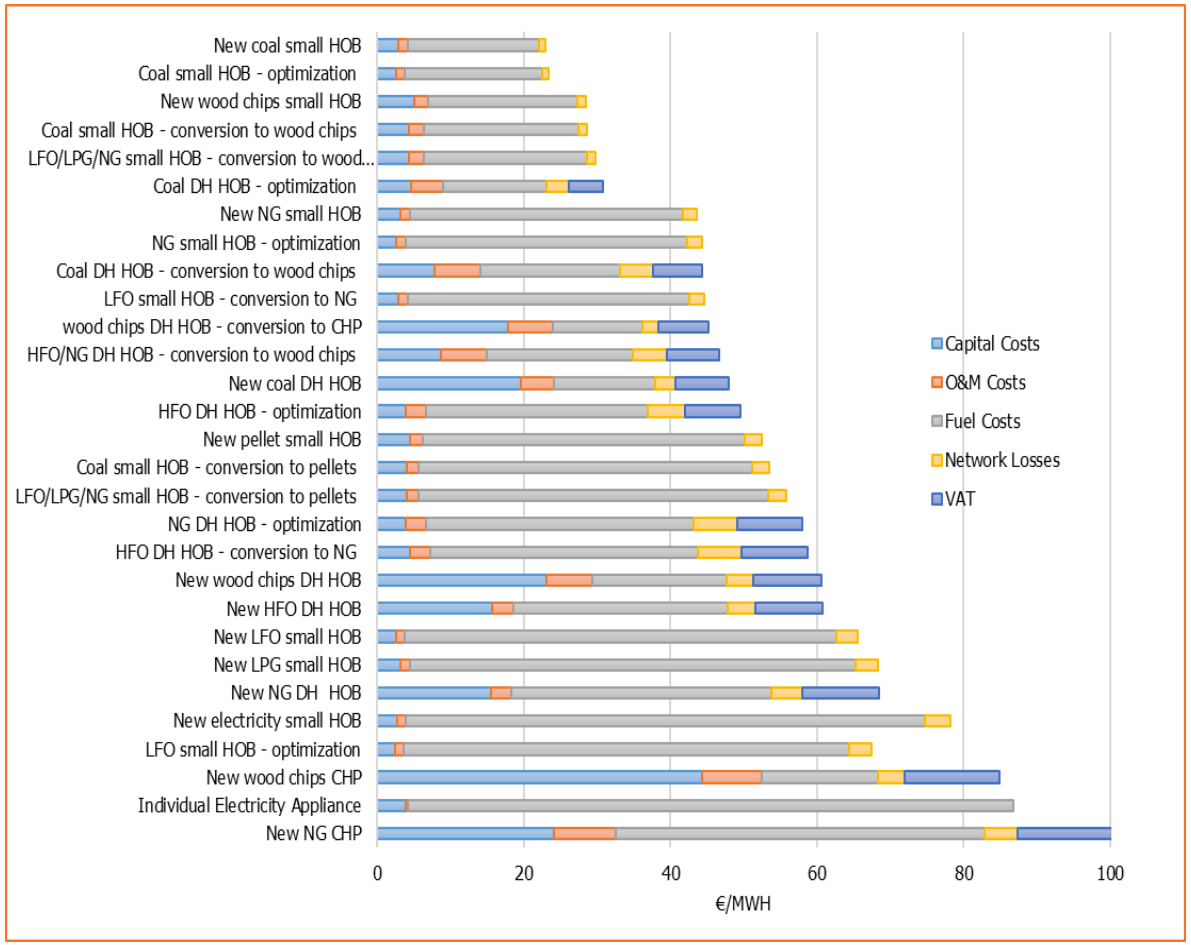
*includes construction of new internal heating network

FYR OF MACEDONIA: Financial viability of heating options

Stand-alone buildings



Multi-store buildings



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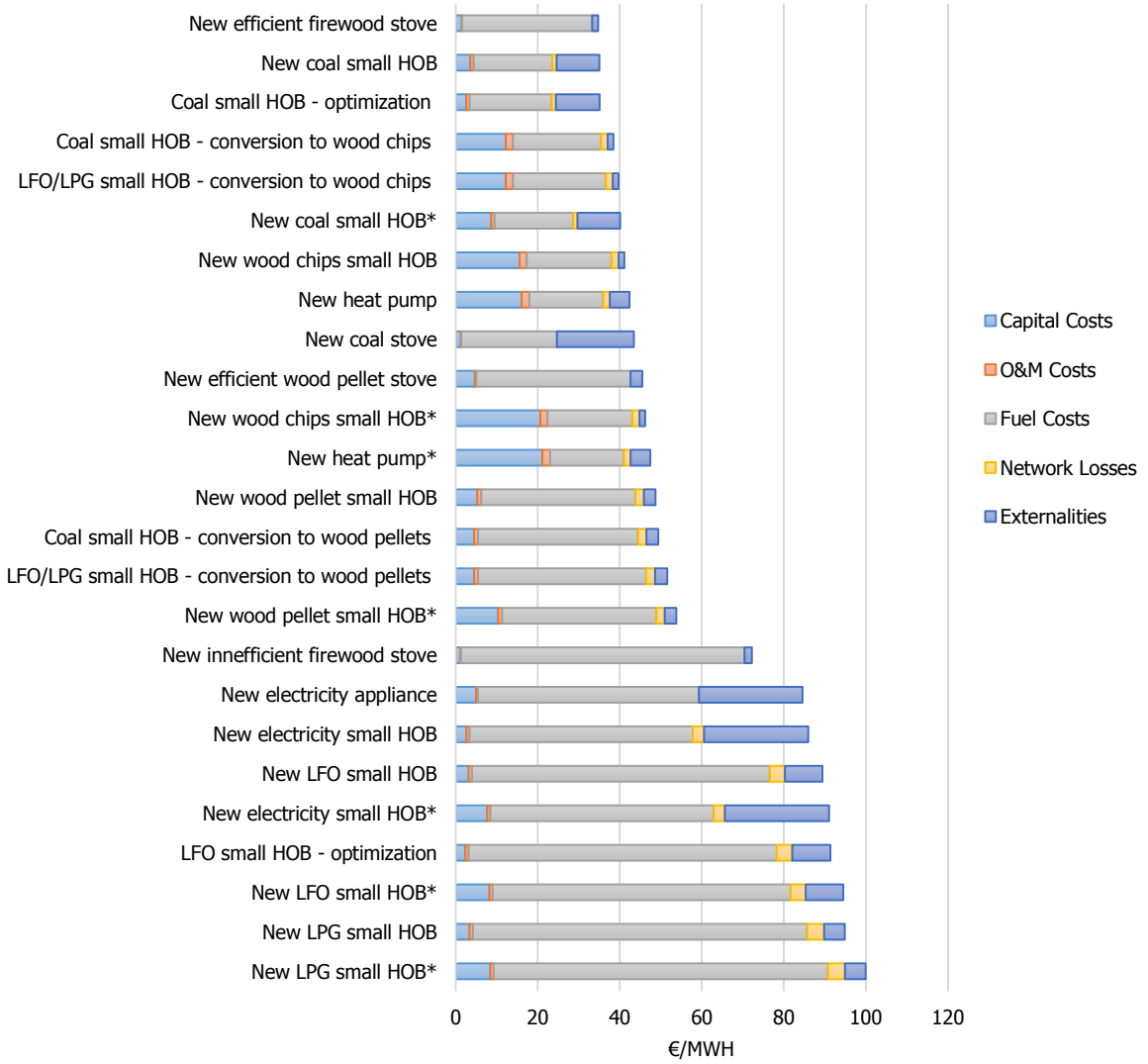
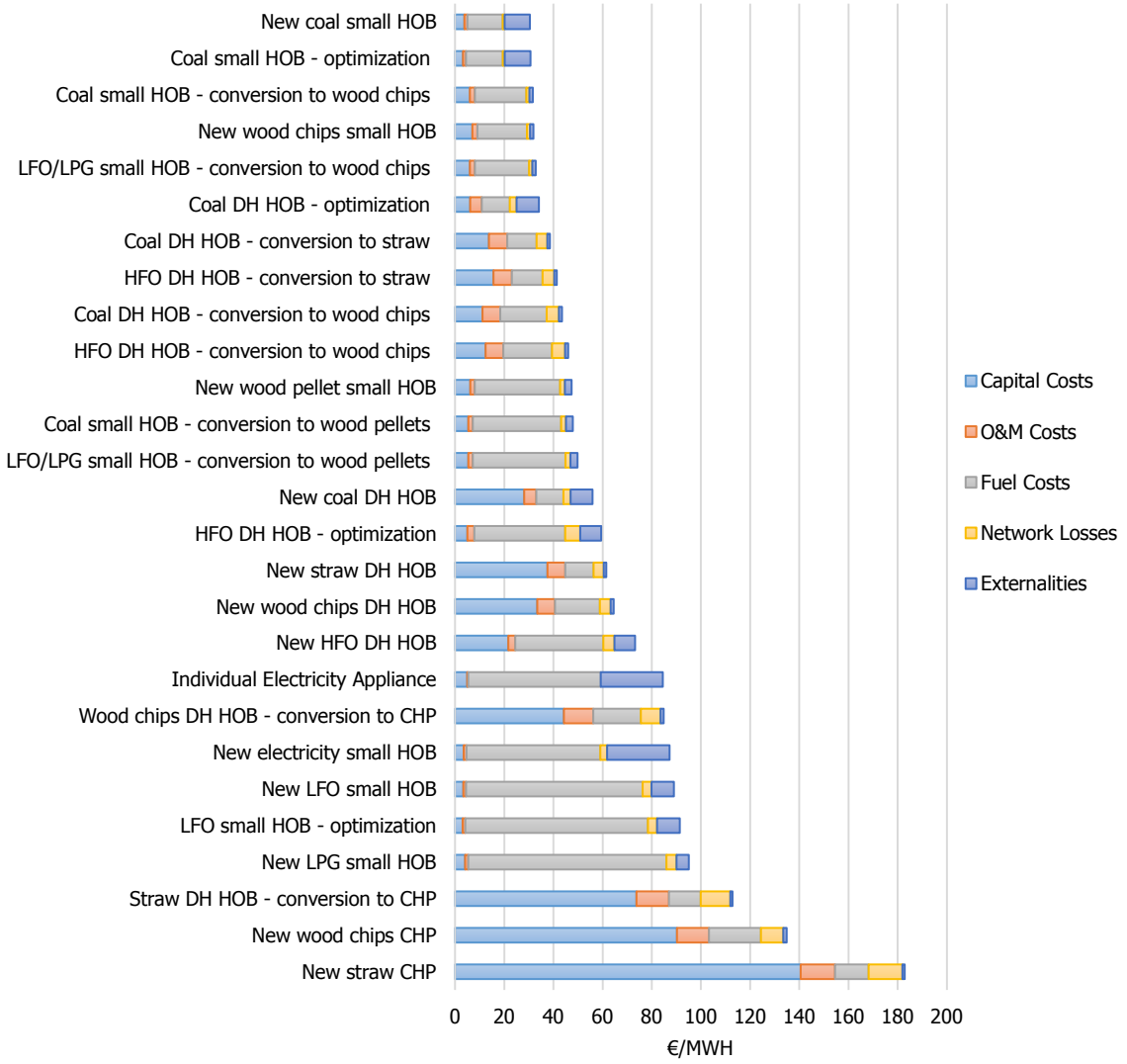
KOSOVO: Economic viability of heating options – stand-alone buildings



KOSOVO	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
STAND-ALONE BUILDINGS	Inefficient wood stoves	**New efficient firewood stove**	New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Individual electric appliance		New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Small HOB-LPG	**LPG small HOB - conversion to wood chips**	New wood chips small HOB New wood pellets small HOB LPG small HOB - conversion to wood pellets
	Small HOB-coal	-	-
	Small HOB-LFO	**LFO small HOB - conversion to wood chips**	New wood chips small HOB New wood pellets small HOB LFO small HOB - conversion to wood pellets

*includes construction of new internal heating network

KOSOVO: Economic viability of heating options – multi-store buildings

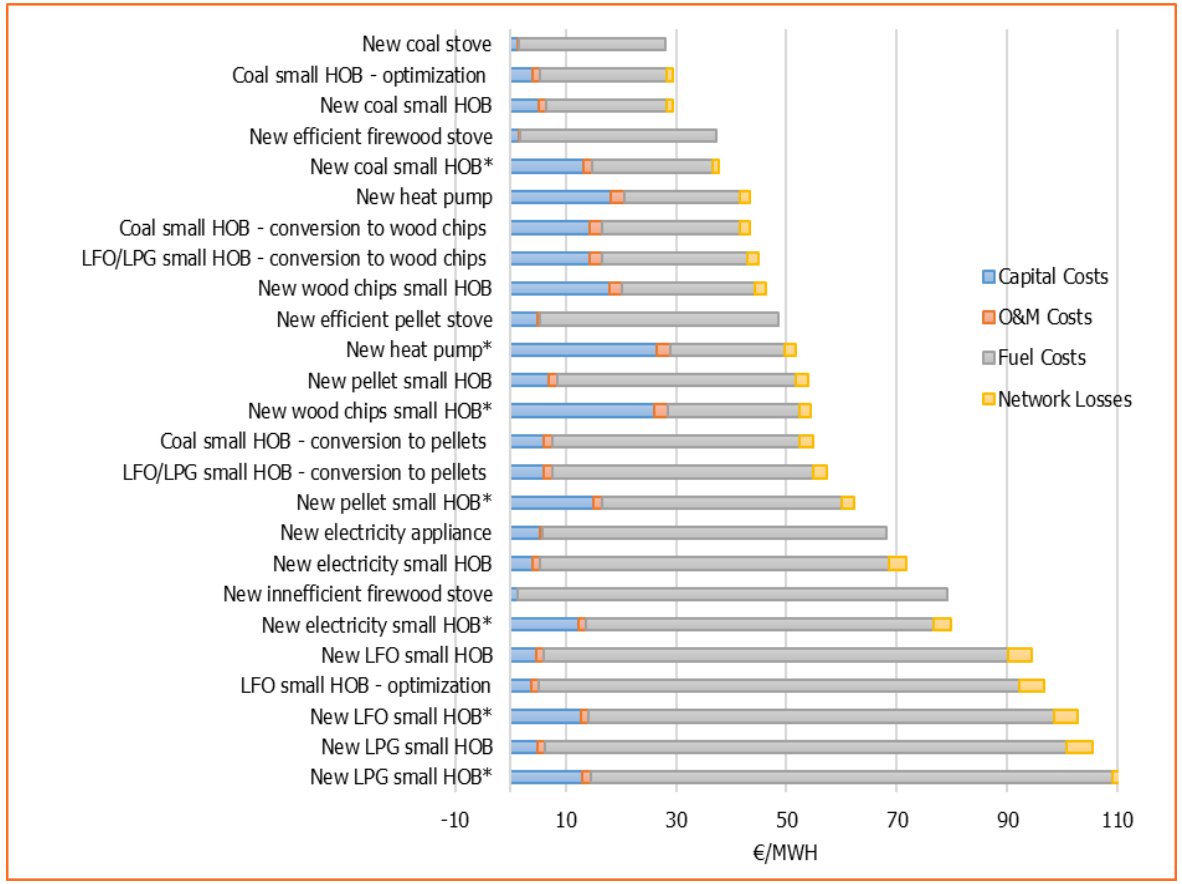


KOSOVO	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
MULTI-STORE BUILDINGS	Individual electric appliance	**New wood chips small HOB**	New wood pellets small HOB New straw DH HOB New wood chips DH HOB
	Small HOB-LFO		LFO small HOB - conversion to wood chips New wood pellets small HOB LFO small HOB - conversion to wood pellets New straw DH HOB New wood chips DH HOB
	Small HOB-coal	-	-
	Small HOB-LPG	**New wood chips small HOB**	LPG small HOB - conversion to wood chips New wood pellets small HOB LPG small HOB - conversion to wood pellets New straw DH HOB New wood chips DH HOB
DH / CHP	DH HOB-HFO	**HFO DH HOB - conversion to straw**	HFO DH HOB - conversion to wood chips New straw DH HOB New wood chips DH HOB

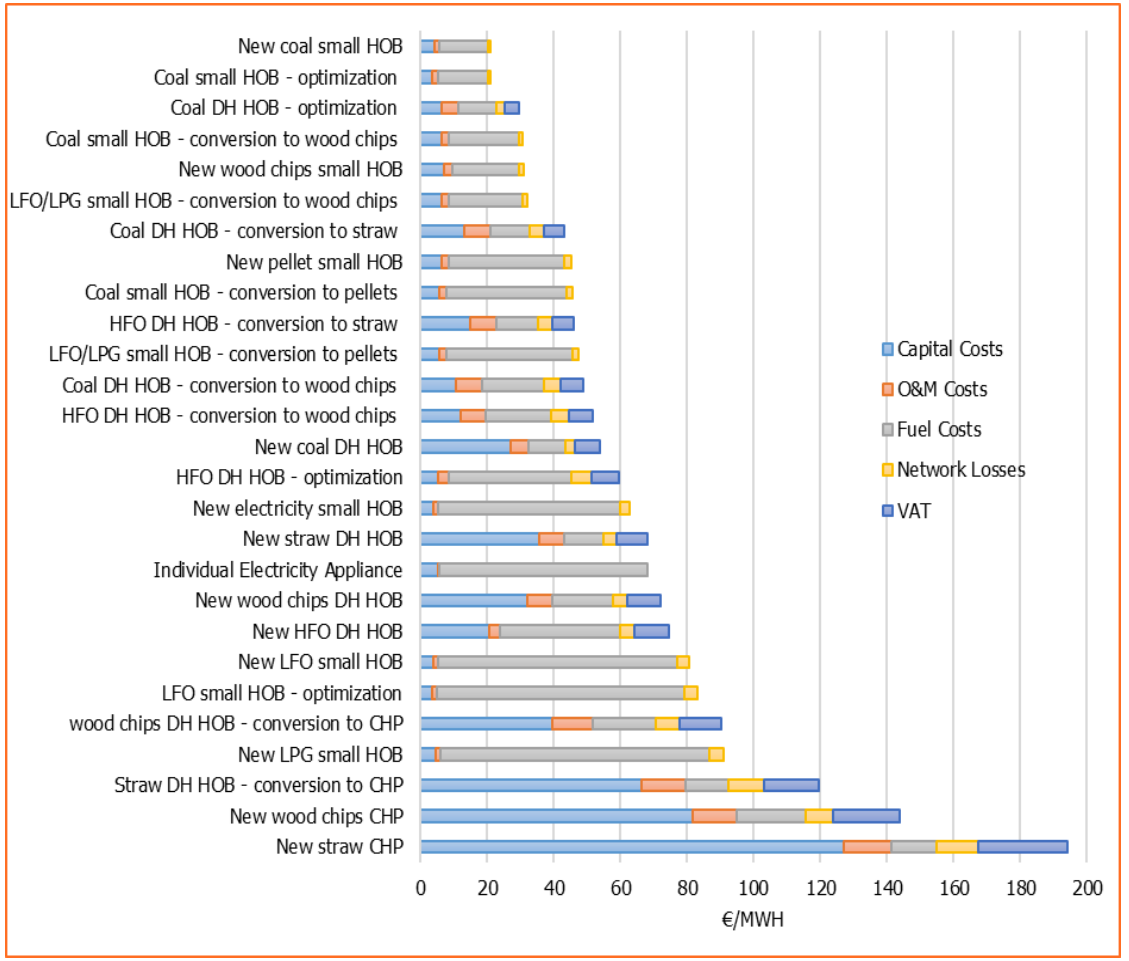
*includes construction of new internal heating network

KOSOVO: Financial viability of heating options

Stand-alone buildings



Multi-store buildings



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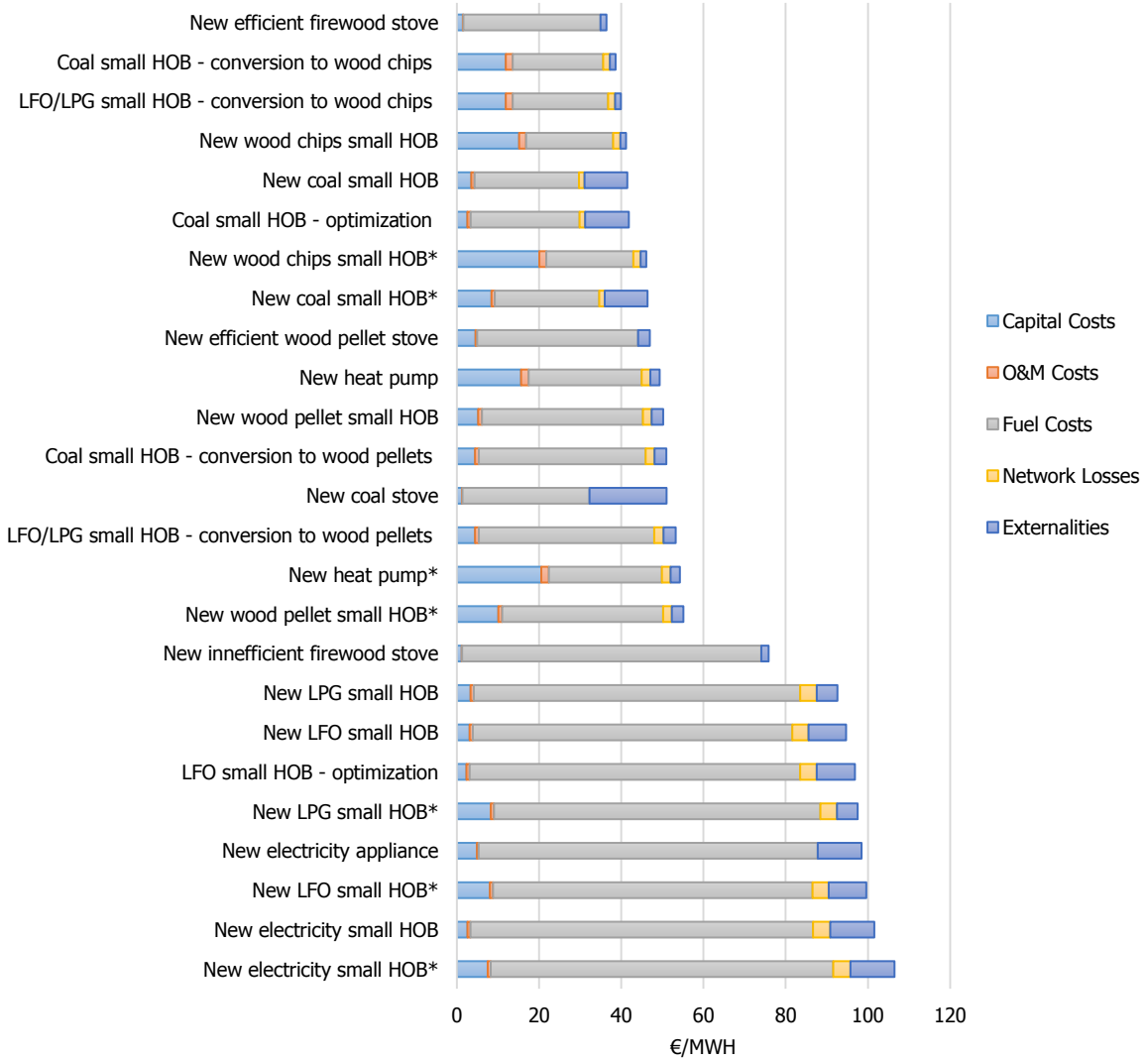
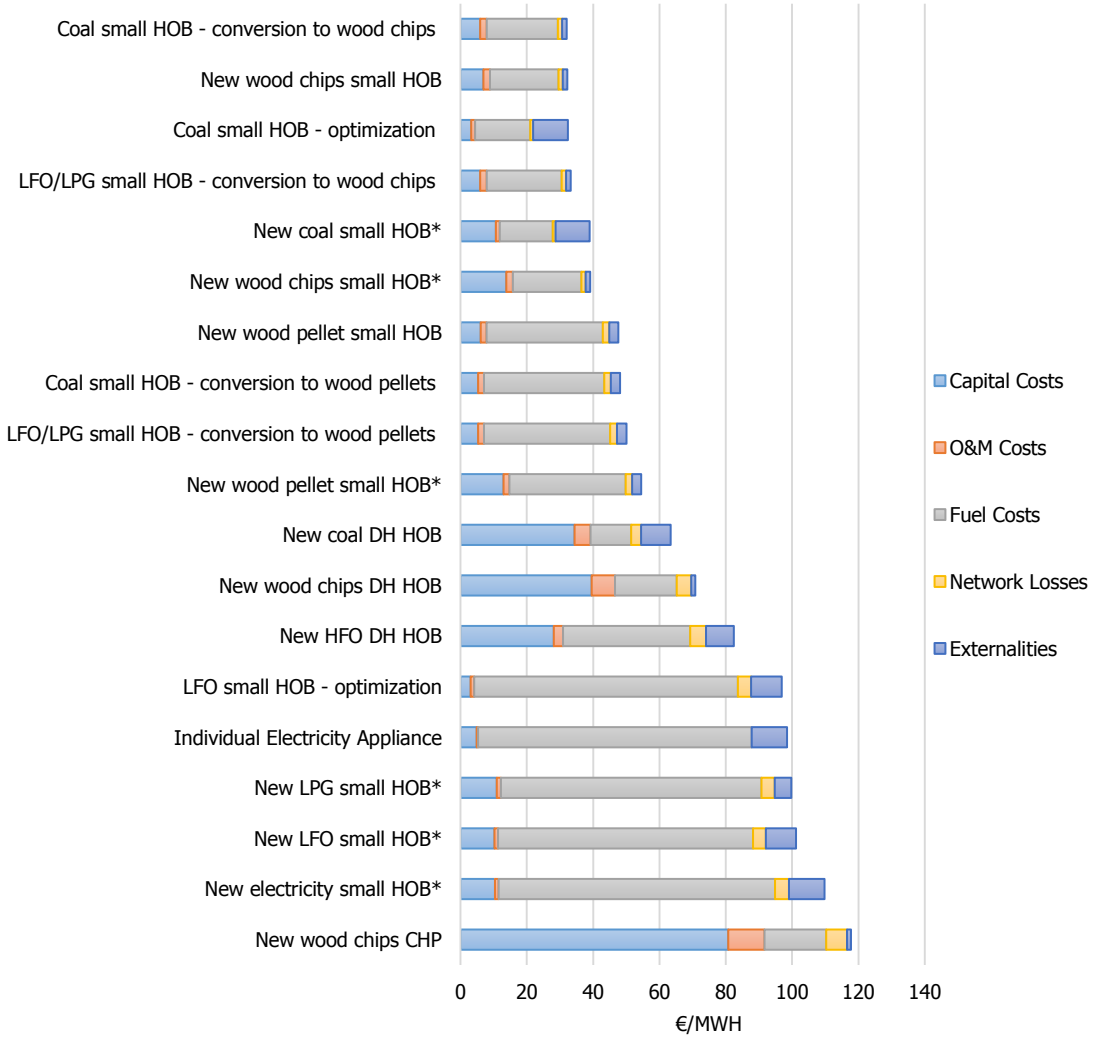
MONTENEGRO: Economic viability of heating options – stand-alone buildings



MONTENEGRO	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
STAND-ALONE BUILDINGS	Inefficient wood stoves	**New efficient firewood stove**	New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Individual electric appliance		New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Small HOB-LFO	**LFO small HOB - conversion to wood chips**	New wood chips small HOB New wood pellets small HOB LFO small HOB - conversion to wood pellets

*includes construction of new internal heating network

MONTENEGRO: Economic viability of heating options – multi-store buildings

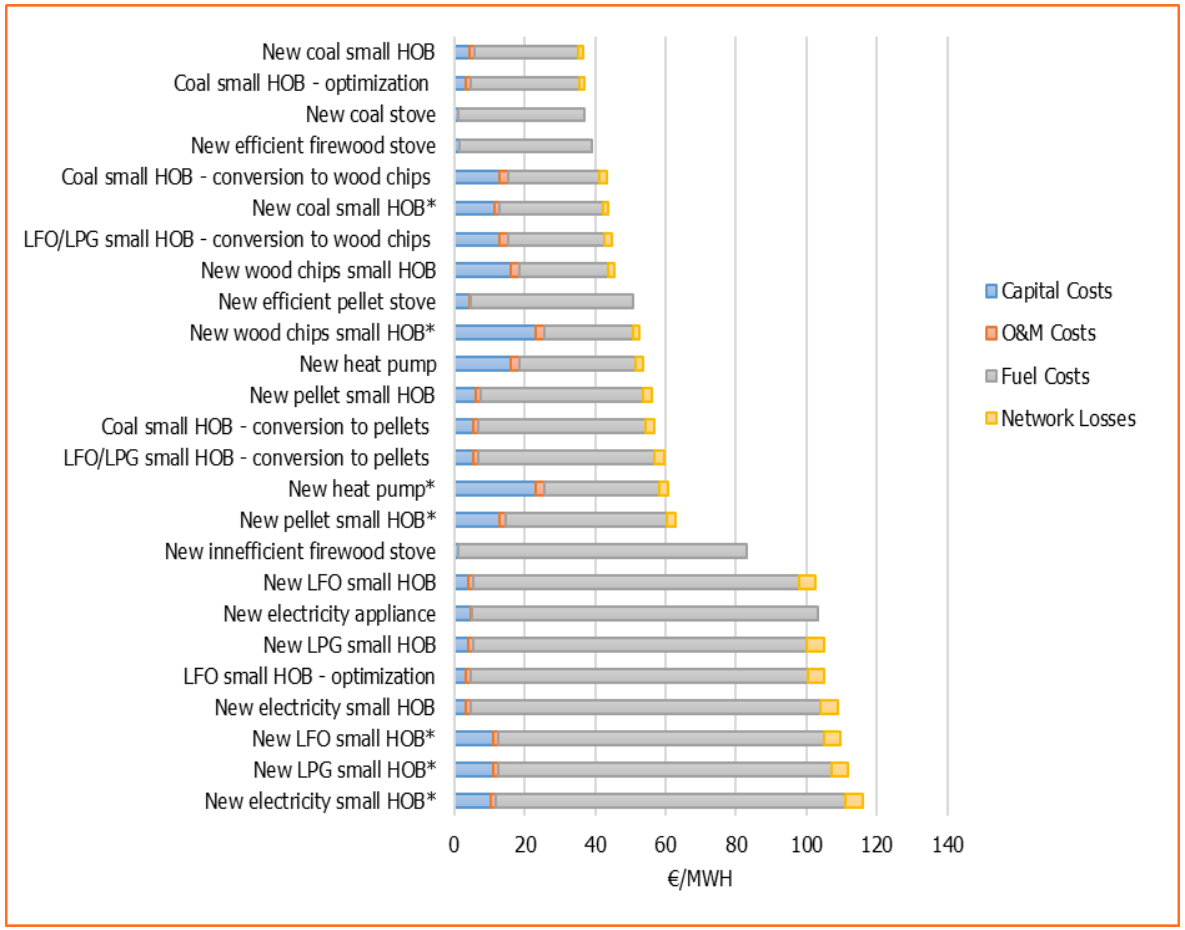


MONTENEGRO	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
MULTI-STORE BUILDINGS	Individual electric appliance	**New wood chips small HOB***	New wood pellets small HOB* New wood chips DH HOB
	Small HOB-coal	**Coal small HOB - conversion to wood chips**	New wood chips small HOB

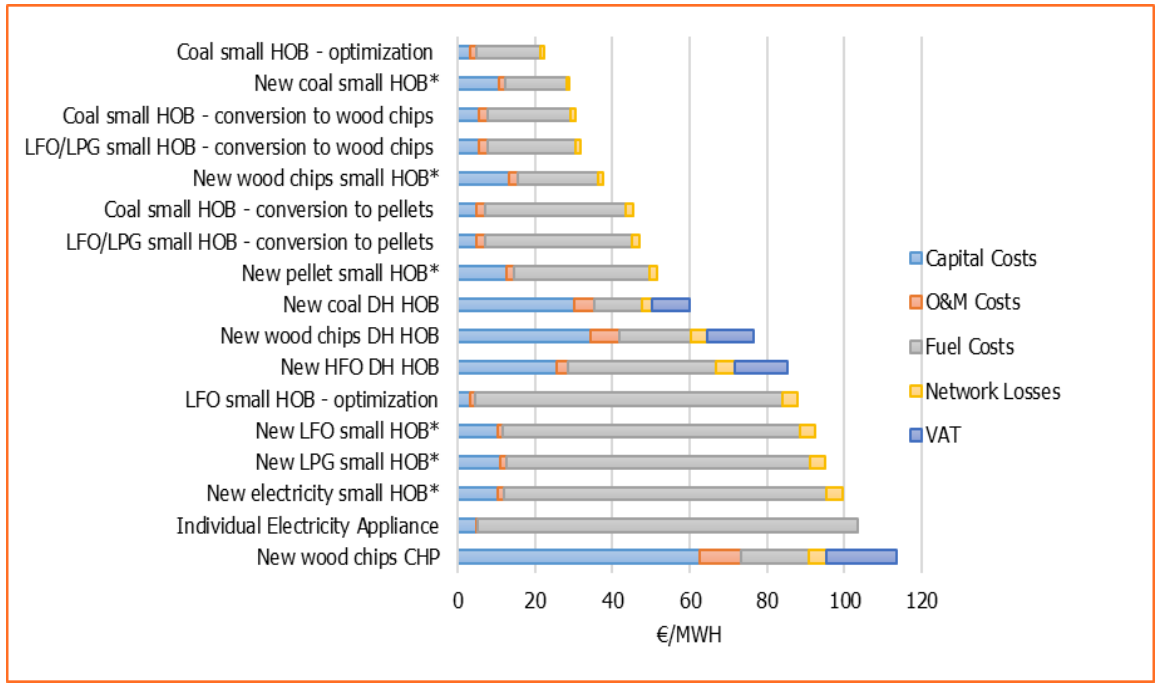
*includes construction of new internal heating network

MONTENEGRO: Financial viability of heating options

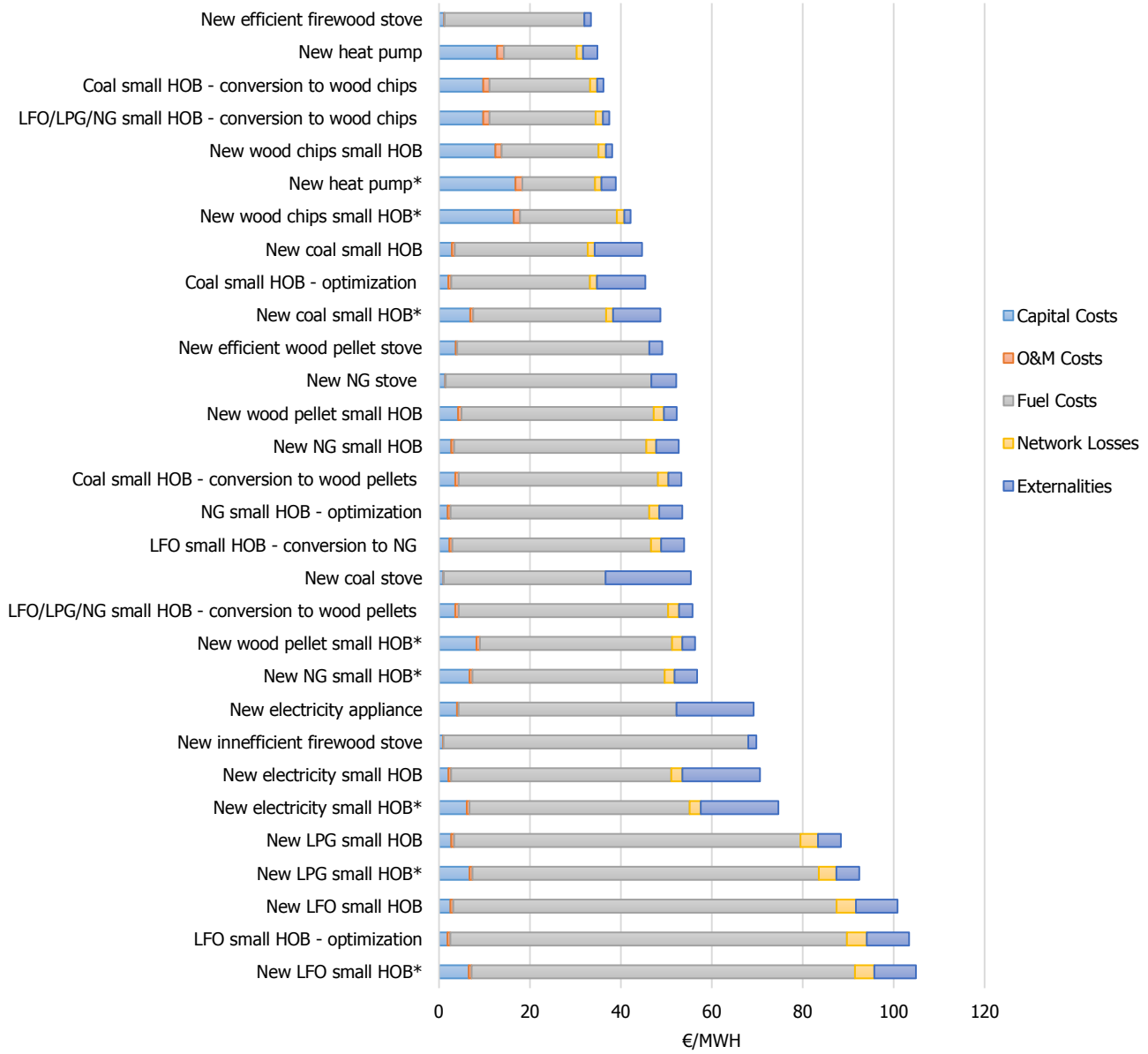
Stand-alone buildings



Multi-store buildings



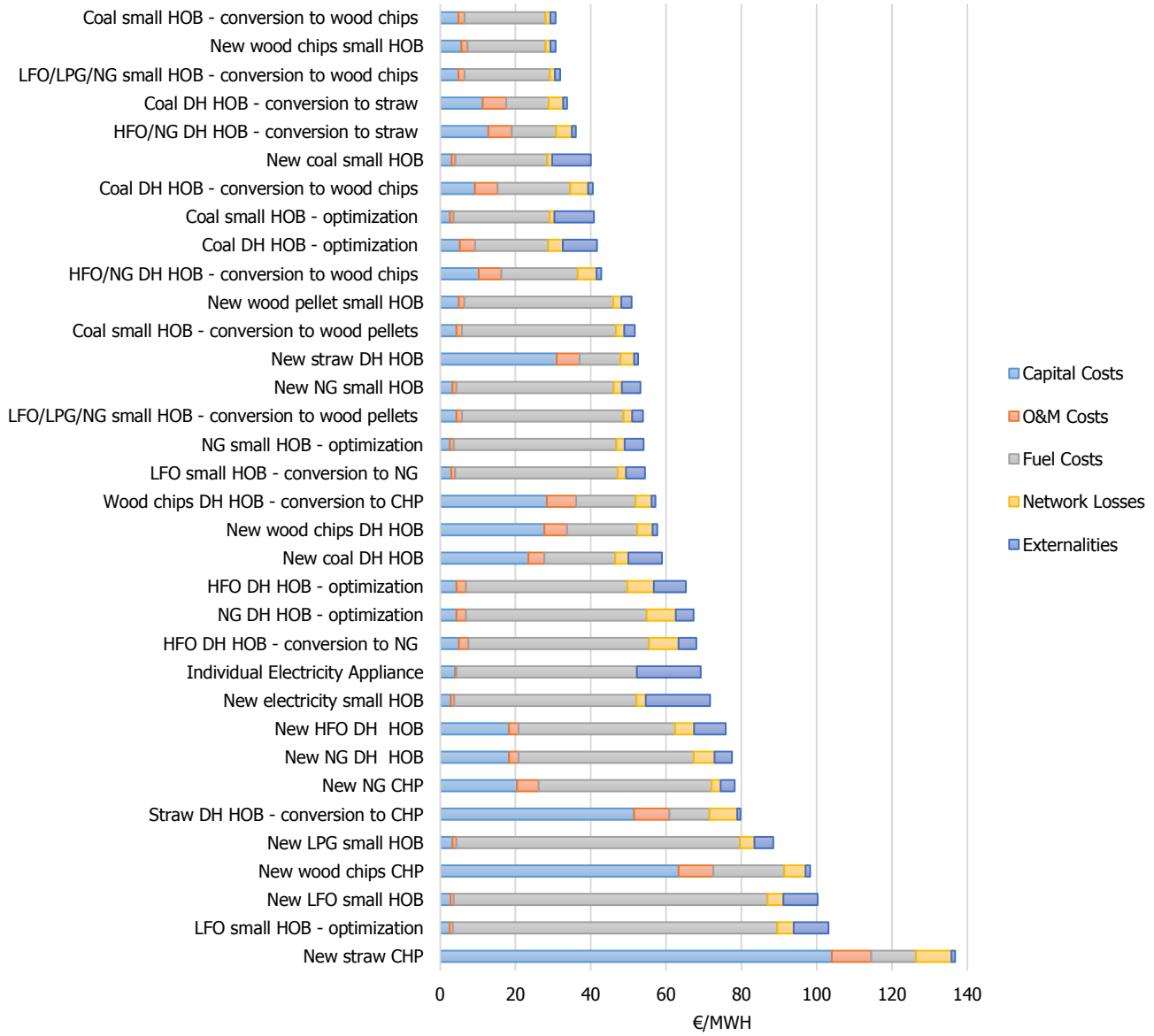
SERBIA: Economic viability of heating options – stand-alone buildings



SERBIA	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
STAND-ALONE BUILDINGS	Inefficient wood stoves	**New efficient firewood stove**	New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Individual electric appliance		New wood chips small HOB* New efficient wood pellet stove New wood pellets small HOB*
	Small HOB-coal	**Coal small HOB - conversion to wood chips**	New wood chips small HOB
	Small HOB-LFO	**LFO small HOB - conversion to wood chips**	New wood chips small HOB New wood pellets small HOB LFO small HOB - conversion to wood pellets
	Small HOB-NG	**NG small HOB - conversion to wood chips**	New wood chips small HOB New wood pellets small HOB
	Coal stoves	**New efficient firewood stove**	New wood chips small HOB* New efficient wood pellet stove
	NG stoves		New wood chips small HOB* New efficient wood pellet stove

*includes construction of new internal heating network

SERBIA: Economic viability of heating options – multi-store buildings

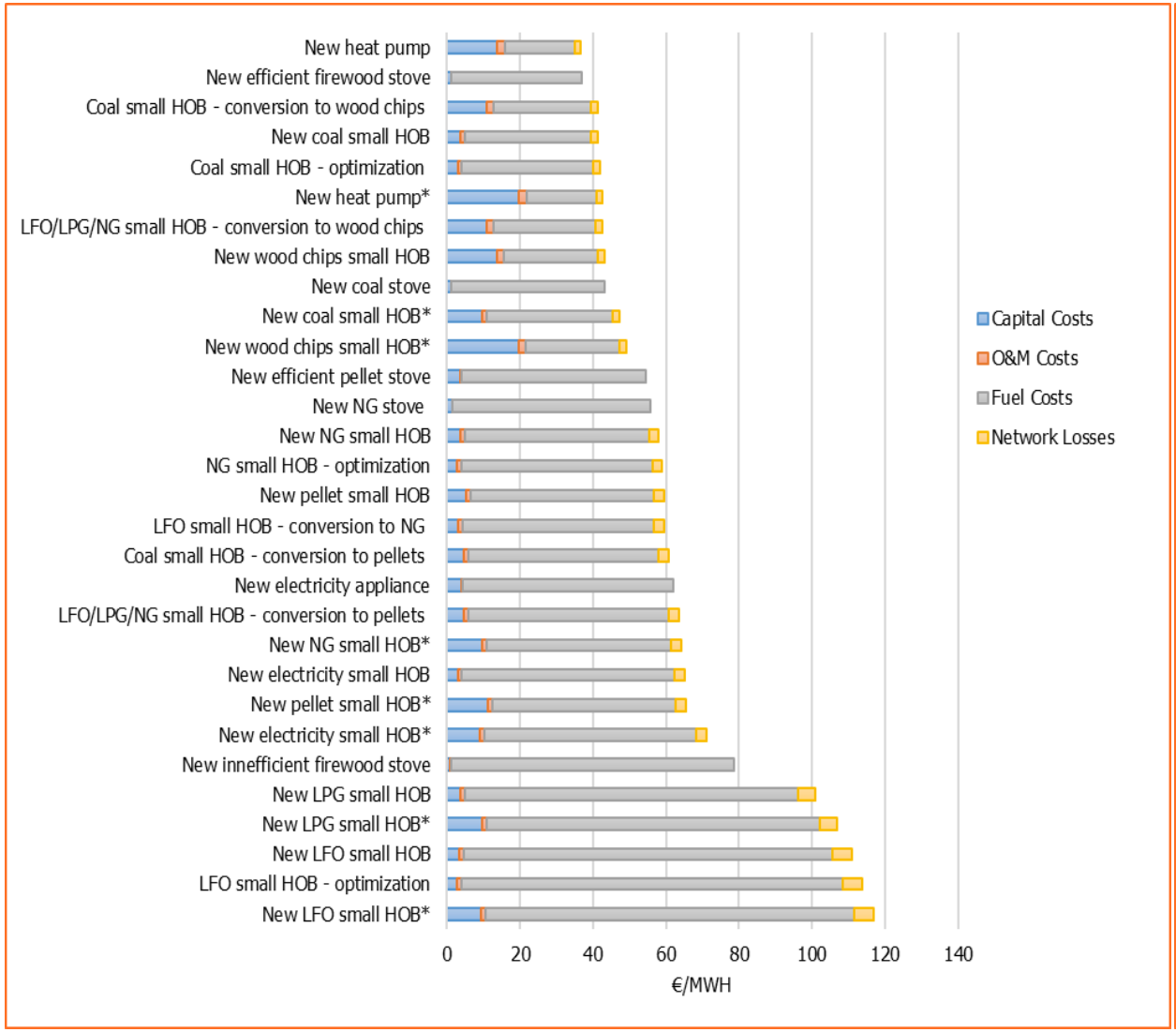


SERBIA	Current heating	Leading economically viable biomass heating option	Alternative economically viable biomass heating options
MULTI-STORE BUILDINGS	Small HOB-coal	**Coal small HOB - conversion to wood chips**	New wood chips small HOB
	Small HOB-NG	**New wood chips small HOB**	NG small HOB - conversion to wood chips New wood pellets small HOB New straw DH HOB
	Individual electric appliance		New wood pellets small HOB New straw DH HOB New wood chips DH HOB
	Small HOB-LFO		LFO small HOB - conversion to wood chips New wood pellets small HOB New straw DH HOB LFO small HOB - conversion to wood pellets New wood chips DH HOB New wood chips CHP
DH / CHP	DH HOB-NG	**NG DH HOB - conversion to straw**	NG DH HOB - conversion to wood chips New straw DH HOB New wood chips DH HOB
	DH HOB-coal	**Coal DH HOB - conversion to straw**	Coal DH HOB - conversion to wood chips New straw DH HOB New wood chips DH HOB
	DH HOB-HFO	**HFO DH HOB - conversion to straw**	HFO DH HOB - conversion to wood chips New straw DH HOB New wood chips DH HOB

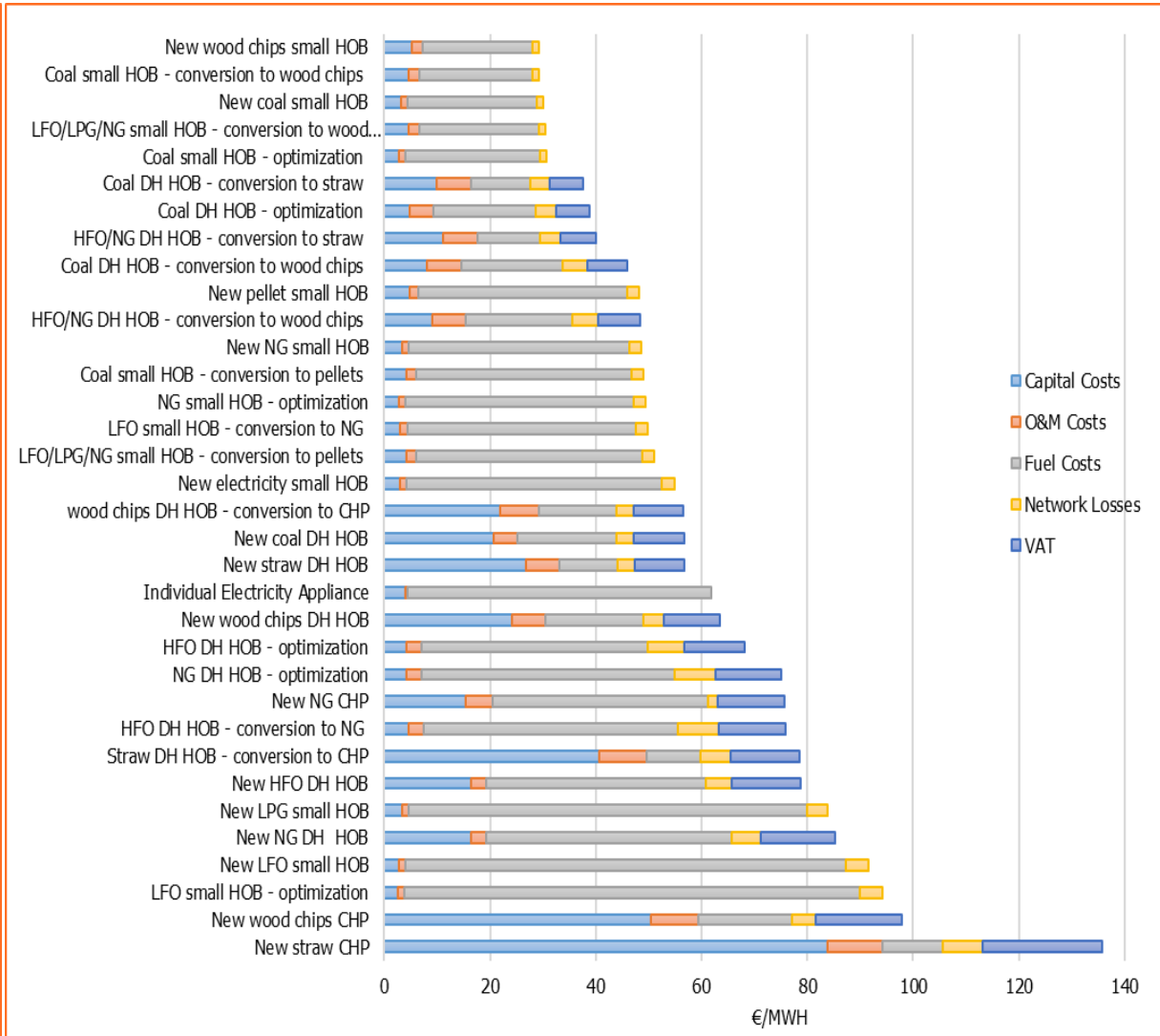
*includes construction of new internal heating network

SERBIA: Financial viability of heating options

Stand-alone buildings



Multi-store buildings



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