8. Supplementary Material

8.1. Proofs

Proof of Proposition 1

Proof.
- (R2) = (R3): As for both (R2) and (R3) we have $\mu \in \mathsf{L}$ and $\mu_(s) = \tilde{\mu}_s(u), s \in X_u$, we only need to prove that $\tilde{\mu}_s \in \text{conv}(X_s), s \in \mathcal{L}$ is equivalent to $\tilde{\mu} \in \mathcal{M}$. By inspecting the definition (6) of $\mathcal{M}$ we see that it is the intersection of (i) $\mu_u \in X_u, u \in \mathsf{V}$ and (ii) $\tilde{\mu}_s \in X_s, s \in \mathcal{L}$. However, by the equality constraints $\mu_u(s) = \tilde{\mu}_s(u)$ constraints (i) are already enforced, in (R2), hence equality follows.
- (R4) = (R5): Analoguously to (R2) = (R3).
- Relaxation (R1) is weaker than (R2) and (R3): Relaxations (R2) and (R3) include additional constraints.

□

8.2. Optimization Subproblems of Procedure 1

In Procedure 1 the two problem in lines 1 and 3 must be solved. Solution of the optimization problem in line 1 was discussed in the main part of the paper. Therefore, it only remains to show how to carry optimization of the problem in line 3 efficiently for all cases that can occur. This is shown in Table 3.

Checking validity of the operations in Table 3 for $i = u \in \mathsf{V}$ and $i = uv \in \mathsf{E}$ is straightforward. For $i = \mathcal{M}$ and $J = \mathsf{V}$, we prove correctness below. Correctness for $i = \mathcal{M}$ and $J = \mathcal{L}$ is analoguous.

Lemma 2. *The reparametrization adjustment problem (9) for $i = \mathcal{M}$ and $J = \mathsf{V}$ is given by (14). Moreover it is the dual of a minimum cost network flow problem.*

Proof. Recall from network flow theory [7], that $x^*_u \in X_u$ is optimal for cost $\tilde{\theta}$, iff $\exists \pi \in \mathbb{R}^{|\mathsf{V}|}, \psi \in \mathbb{R}^{|\mathcal{L}|}$ such that

$$\tilde{\theta}_u(x_u) - \pi(u) + \psi(x_u) \begin{cases} \leq 0, & x^*_u(x_u) = 1 \\ \geq 0, & x^*_u(x_u) = 0 \end{cases} \forall u \in \mathsf{V}, x_u \in X_u \,.$$

Consider the primal/dual pair

$$\begin{array}{ll} \min_{(\mu_u)_{u\in\mathsf{V}}} \sum_{u\in\mathsf{V}} \langle \tilde{\theta}_u, \mu_u \rangle & \max_{\Delta,\pi,\psi} \sum_{u\in\mathsf{V}} \langle \Delta_u, \delta_u \rangle \\ \forall u \in \mathsf{V}, \sum_{x_u \in X_u} \mu_u(x_u) = 0 & \pi(u) \in \mathbb{R} \\ \forall l \in \mathcal{L}, -\sum_{u: l \in X_u} \mu_u(l) = 0 & \psi(l) \in \mathbb{R} \\ \mu_u(x_u) \begin{cases} \geq \delta_u(x_u), & x_u \neq x^*_u \\ \leq \delta_u(x_u), & x_u = x^*_u \end{cases} & \Delta_u(x_u) \in \begin{cases} \geq 0, & x^*_u = x_u \\ \leq 0, & x^*_u \neq x_u \end{cases} \\ \mu_u(x_u) \in \mathbb{R} & \tilde{\theta}_u(x_u) + \Delta_u(x_u) + \pi(u) - \psi(x_u) = 0 \end{array} \tag{12}$$

On the right side, the adjustment problem (3) is written down explicitly. The left hand side is a minimum cost flow problem, hence the second part of the claim is proven.

The last equality above on the right hand side ensures that $\Delta_u(x_u) = -\tilde{\theta}_u(x_u) - \pi(u) + \psi(x_u)$. Substituting this everywhere on the right hand side of (12) gives

$$\begin{array}{ll} \max_{\pi,\psi} & \sum_{u\in\mathsf{V}} \pi(u) \cdot \left(\sum_{x_u \in X_u} \delta_u(x_u)\right) + \sum_{l\in\mathcal{L}} \psi(l) \cdot \left(\sum_{u\in\mathsf{V}: l \in X_u} \delta_u(l)\right) \\ \text{s.t.} & \pi(u) \in \mathbb{R} \\ & \psi(l) \in \mathbb{R} \\ & \tilde{\theta}_u(x_u) + \pi(u) - \psi(x_u) \begin{cases} \leq 0, & x^*_u = x_u \\ \geq 0, & x^*_u \neq x_u \end{cases} \end{array} \tag{13}$$

This form matches the format given in (14). □

8.3. Time complexity

The time complexity of running one iteration of message passing is essentially the time to run all required invocations of Algorithm 1 via the routines described in Table 3. Total runtime per iteration for the various algorithms we have proposed can

be found in Table 4. We assume that $X_u = \mathcal{L}\ \forall u \in \mathsf{V}$. In sparse assignment problems, where this is not the case, run-time decreases according to sparsity.

If we hold the unary potentials θ_u, $u \in \mathsf{V}$ in a heap, we can support operation $\min_{s' \in J \cap X_u} \theta_u(s')$ which is required in the third line in Table 3 in time $\log(|\mathcal{L}|)$, since either $J \cap X_u = X_u$ (sending) or $|J \cap X_u| = 1$ (receiving).

Hence, all our algorithms scale to realistic problem sizes.

8.4. Detailed Experimental Evaluation

Plots showing lower bound and primal solution energy per over time can be seen in Figure 2.

In Table 5 dataset statistics are given together with final upper and lower bound as well as runtime averaged over all instances in specific datasets are given.

A per-instance evaluation of all considered algorithms can be found in Table 6.

Algorithm 1 input $i \in \mathbb{V}$	$J \subseteq \mathcal{N}_{\mathbb{G}}(i)$	Solution $\Delta^*_{(i,j)}\ \forall j \in J$ of (9)
$i = u \in \mathsf{V}$	$J \subseteq \mathsf{E} \cup \{\mathcal{M}\} \cup \mathcal{L}$	$\Delta^*_{(u,uv)} = {}^{(\theta_u - \min_{x_u \in X_u} \theta_u(x_u))}/_{\lvert J \rvert}\ \forall uv \in \mathsf{E} \cap J$ $\Delta^*_{(u,\mathcal{M})} = {}^{(\theta_u - \min_{x_u \in X_u} \theta_u(x_u))}/_{\lvert J \rvert}$ $\Delta^*_{(u,s)} = {}^{(\theta_u(s) - \min_{s' \notin J \cap X_u} \theta_u(s'))}/_{\lvert J \rvert}\ \forall s \in X_u \cap J$
$i = uv \in \mathsf{E}$	$J = \{u\}, u \in \mathsf{V}$	$\Delta^*_{(uv,u)}(x_u) = \min_{x_v \in X_v} \{\theta_{uv}(x_u, x_v)\} - \min_{x_{uv} \in X_{uv}} \{\theta_{uv}(x_{uv})\}$
$i = \mathcal{M}$	$J = \mathsf{V}$	$\Delta_u(x_u) = -\tilde{\theta}_u(x_u) - \pi^*(u) + \psi^*(x_u)$ $(\pi^*, \psi^*) \in \operatorname{argmax}_{\pi,\psi} \sum_{u \in \mathsf{V}} \pi(u) \cdot \left(\sum_{x_u \in X_u} \delta_u(x_u)\right) + \sum_{l \in \mathcal{L}} \psi(l) \cdot \left(\sum_{u \in \mathsf{V}: l \in X_u} \delta_u(l)\right)$ s.t. $\tilde{\theta}_u(x_u) + \pi(u) - \psi(x_u) \begin{cases} \leq 0, & x^*_u = x_u \\ \geq 0, & x^*_u \neq x_u \end{cases}$ (14)
$i = \mathcal{M}$	$J = \mathcal{L}$	$\Delta_s(u) = -\tilde{\theta}_u(s) - \pi^*(u) + \psi^*(s)$ $(\pi^*, \psi^*) \in \operatorname{argmax}_{\pi,\psi} \sum_{u \in \mathsf{V}} \pi(u) \cdot \left(\sum_{x_u \in X_u} \delta_{x_u}(u)\right) + \sum_{l \in \mathcal{L}} \psi(l) \cdot \left(\sum_{u \in \mathsf{V}: l \in X_u} \delta_l(u)\right)$ s.t. $\tilde{\theta}_u(x_u) + \pi(u) - \psi(x_u) \begin{cases} \leq 0, & x^*_u = x_u \\ \geq 0, & x^*_u \neq x_u \end{cases}$ (15)

Table 3. Message computation problems (9)

Algorithm	Time complexity
GM	$O(\lvert\mathcal{L}\rvert \cdot \lvert\mathsf{V}\rvert + \lvert\mathcal{L}\rvert^2 \cdot \lvert\hat{\mathsf{E}}\rvert)$
AMP	$O(\lvert\mathcal{L}\rvert \cdot \lvert\mathsf{V}\rvert + \lvert\mathcal{L}\rvert^2 \cdot \lvert\mathsf{E}\rvert + \lvert\mathcal{L}\rvert^3)$
AMP†	$O(\lvert\mathcal{L}\rvert \cdot \lvert\mathsf{V}\rvert + \lvert\mathcal{L}\rvert^2 \cdot \lvert\mathsf{E}\rvert + \lvert\mathcal{L}\rvert^2 \cdot \log\lvert\mathcal{L}\rvert)$
AMCF	$O(\lvert\mathcal{L}\rvert \cdot \lvert\mathsf{V}\rvert + \lvert\mathcal{L}\rvert^2 \cdot \lvert\mathsf{E}\rvert + MCF(\lvert\mathsf{V}\rvert, \lvert\mathsf{V}\rvert^2))$

Table 4. Time complexity per iteration for the three proposed algorithms. $MCF(n, m)$ is the time to solve a min-cost-flow problem on a graph with n nodes and m edges: Orlin's algorithm has time complexity $O(m^2 \log n + m \log^2 n)$ [7]. **AMP**† stores reparametrized unary costs in a heap to accelerate computation of the messages between label factors and unaries.

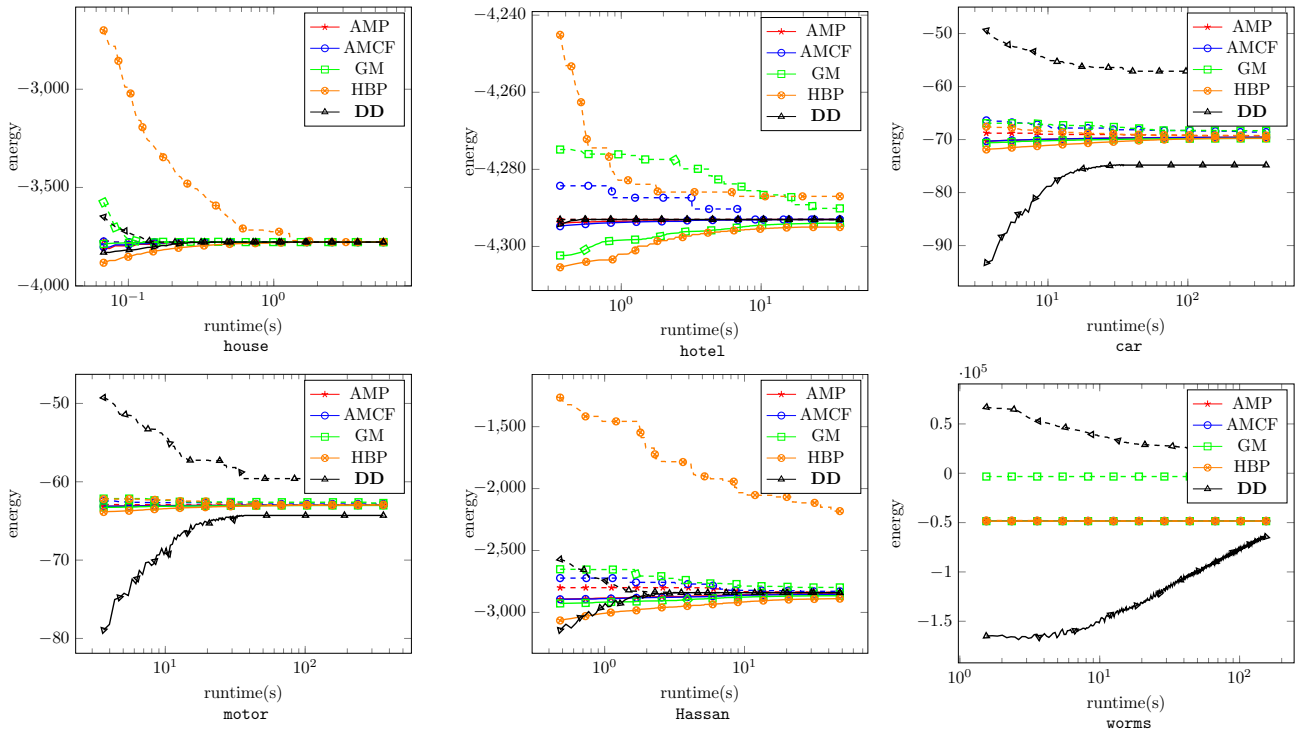

Figure 2. Runtime plots for `house`, `hotel`, `car`, `motor`, `graph flow` and `worms` datasets. Continuous lines denote dual lower bounds and dashed ones primal energies. Values are averaged over all instances of the dataset. The x-axis is logarithmic.

Dataset/**Algorithm**				**AMP**	**AMCF**	**GM**	**HBP**	**DD**
hotel	#I	105	LB	**-4293.00**	**-4293.00**	-4293.94	-4294.98	**-4293.00**
	#V	30	UB	**-4293.00**	**-4293.00**	-4290.12	-4287.00	**-4293.00**
	#L	30	time(s)	3.07	4.31	14.91	16.76	**0.42**
house	#I	105	LB	**-3778.13**	**-3778.13**	**-3778.13**	**-3778.13**	**-3778.13**
	#V	30	UB	**-3778.13**	**-3778.13**	**-3778.13**	**-3778.13**	**-3778.13**
	#L	30	time(s)	2.81	3.02	**1.63**	14.76	2.36
graph flow	#I	6	LB	-2849.96	-2853.95	-2865.20	-2888.88	**-2840.29**
	#V	≤ 126	UB	-2836.57	-2829.49	-2798.11	-2181.96	**-2840.00**
	#L	≤ 126	time(s)	218.22	231.53	216.39	194.43	**17.92**
car	#I	30	LB	**-69.56**	-69.57	-69.78	-69.77	-74.17
	#V	≤ 49	UB	**-69.27**	-68.58	-68.32	-69.23	-57.11
	#L	≤ 49	time(s)	656.86	698.74	776.58	572.41	**83.71**
motor	#I	20	LB	**-62.97**	-62.98	-63.02	-62.98	-64.25
	#V	≤ 52	UB	**-62.95**	-62.83	-62.71	-62.93	-59.60
	#L	≤ 52	time(s)	70.82	98.57	285.19	317.61	**69.22**
worms	#I	30	LB	**-48471.21**	-48491.81	-48517.50	-48495.92	-62934.54
	#V	≤ 605	UB	**-48453.90**	-48305.90	-3316.69	-48288.65	-5254.08
	#L	≤ 1500	time(s)	**213.89**	614.80	229.21	295.67	1471.95

Table 5. Description of datasets together with averaged algorithm results over all instances. #I means number of instances in dataset, #V the number of nodes per instance, #L the number of labels per instance, LB means lower bound, UB upper bound. **Bold numbers** indicate highest lower bound, lowest primal energy and smallest runtime.

Table 6: Per-instance results. UB means primal solution energy, LB dual lower bound and runtime(s) the runtime of the particular algorithm in seconds. **Bold numbers** indicate lowest primal energy, highest lower bound and smallest runtime.

Instance		AMP	AMCF	GM	HBP	DD
hotel						
energy_hotel_frame15frame22	UB	**-4598.04**	**-4598.04**	**-4598.04**	**-4598.04**	**-4598.04**
	LB	**-4598.04**	**-4598.04**	**-4598.04**	**-4598.04**	**-4598.04**
	runtime(s)	0.15	0.14	**0.02**	0.32	0.03
energy_hotel_frame15frame29	UB	**-4540.81**	**-4540.81**	**-4540.81**	**-4540.81**	**-4540.81**
	LB	**-4540.81**	**-4540.81**	**-4540.81**	**-4540.81**	**-4540.81**
	runtime(s)	0.23	0.14	**0.02**	0.32	0.04
energy_hotel_frame15frame36	UB	**-4481.33**	**-4481.33**	**-4481.33**	**-4481.33**	**-4481.33**
	LB	**-4481.33**	**-4481.33**	**-4481.33**	**-4481.33**	**-4481.33**
	runtime(s)	0.48	0.46	**0.02**	0.42	0.04
energy_hotel_frame15frame43	UB	**-4377.31**	**-4377.31**	**-4377.31**	**-4377.31**	**-4377.31**
	LB	**-4377.31**	**-4377.31**	**-4377.31**	**-4377.31**	**-4377.31**
	runtime(s)	0.47	0.46	0.13	0.52	**0.06**
energy_hotel_frame15frame50	UB	**-4294.04**	**-4294.04**	**-4294.04**	**-4294.04**	**-4294.04**
	LB	**-4294.04**	**-4294.04**	**-4294.04**	**-4294.04**	**-4294.04**
	runtime(s)	0.47	0.46	0.13	0.63	**0.07**
energy_hotel_frame15frame57	UB	**-4244.75**	**-4244.75**	**-4244.75**	**-4244.75**	**-4244.75**
	LB	**-4244.75**	**-4244.75**	**-4244.75**	**-4244.75**	**-4244.75**
	runtime(s)	0.48	0.46	0.13	0.72	**0.12**
energy_hotel_frame15frame64	UB	**-4172.32**	**-4172.32**	**-4172.32**	**-4172.32**	**-4172.32**
	LB	**-4172.32**	**-4172.32**	**-4172.32**	**-4172.32**	**-4172.32**
	runtime(s)	0.47	0.46	**0.13**	3.56	0.18
energy_hotel_frame15frame71	UB	**-4135.78**	**-4135.78**	**-4135.78**	**-4135.78**	**-4135.78**
	LB	**-4135.78**	**-4135.78**	**-4135.78**	**-4135.78**	**-4135.78**
	runtime(s)	0.80	0.79	0.35	4.83	**0.30**
energy_hotel_frame15frame78	UB	**-4036.15**	**-4036.15**	**-4036.15**	**-4036.15**	**-4036.15**
	LB	**-4036.15**	**-4036.15**	**-4036.15**	**-4036.15**	**-4036.15**
	runtime(s)	1.50	1.41	6.45	17.64	**0.70**
energy_hotel_frame15frame85	UB	**-3985.99**	**-3985.99**	**-3985.99**	**-3985.99**	**-3985.99**
	LB	**-3985.99**	**-3985.99**	**-3985.99**	**-3985.99**	**-3985.99**
	runtime(s)	1.92	2.04	14.64	28.40	**0.66**
energy_hotel_frame15frame92	UB	**-3898.11**	**-3898.11**	**-3898.11**	**-3898.11**	**-3898.11**
	LB	**-3898.11**	**-3898.11**	**-3898.11**	**-3898.11**	**-3898.11**
	runtime(s)	3.25	4.78	31.59	99.60	**1.93**
energy_hotel_frame15frame99	UB	**-3860.42**	**-3860.42**	**-3860.42**	**-3860.42**	**-3860.42**
	LB	**-3860.42**	**-3860.42**	**-3860.42**	-3869.73	**-3860.42**
	runtime(s)	11.24	11.89	160.82	192.49	**1.15**
energy_hotel_frame1frame15	UB	**-4498.03**	**-4498.03**	**-4498.03**	**-4498.03**	**-4498.03**
	LB	**-4498.03**	**-4498.03**	**-4498.03**	**-4498.03**	**-4498.03**
	runtime(s)	0.15	0.23	**0.02**	0.32	0.04
energy_hotel_frame1frame22	UB	**-4438.33**	**-4438.33**	**-4438.33**	**-4438.33**	**-4438.33**
	LB	**-4438.33**	**-4438.33**	**-4438.33**	**-4438.33**	**-4438.33**
	runtime(s)	0.47	0.65	0.13	0.32	**0.05**
energy_hotel_frame1frame29	UB	**-4368.55**	**-4368.55**	**-4368.55**	**-4368.55**	**-4368.55**
	LB	**-4368.55**	**-4368.55**	**-4368.55**	**-4368.55**	**-4368.55**
	runtime(s)	0.56	0.47	0.13	0.72	**0.05**
energy_hotel_frame1frame36	UB	**-4306.23**	**-4306.23**	**-4306.23**	**-4306.23**	**-4306.23**
	LB	**-4306.23**	**-4306.23**	**-4306.23**	**-4306.23**	**-4306.23**
	runtime(s)	0.48	0.64	0.13	0.61	**0.06**
energy_hotel_frame1frame43	UB	**-4194.42**	**-4194.42**	**-4194.42**	**-4194.42**	**-4194.42**
	LB	**-4194.42**	**-4194.42**	**-4194.42**	**-4194.42**	**-4194.42**
	runtime(s)	0.47	0.64	**0.13**	1.12	0.33
energy_hotel_frame1frame50	UB	**-4125.68**	**-4125.68**	**-4125.68**	**-4125.68**	**-4125.68**
	LB	**-4125.68**	**-4125.68**	**-4125.68**	**-4125.68**	**-4125.68**
	runtime(s)	0.48	0.46	**0.13**	1.12	0.26
energy_hotel_frame1frame57	UB	**-4064.73**	**-4064.73**	**-4064.73**	**-4064.73**	**-4064.73**
	LB	**-4064.73**	**-4064.73**	**-4064.73**	**-4064.73**	**-4064.73**
	runtime(s)	0.80	0.79	0.35	5.65	**0.33**
energy_hotel_frame1frame64	UB	**-4021.19**	**-4021.19**	**-4021.19**	**-4021.19**	**-4021.19**
	LB	**-4021.19**	**-4021.19**	**-4021.19**	**-4021.19**	**-4021.19**
	runtime(s)	1.26	1.09	**0.58**	6.41	0.67

Table 6: Per-instance results. UB means primal solution energy, LB dual lower bound and runtime(s) the runtime of the particular algorithm in seconds. **Bold numbers** indicate lowest primal energy, highest lower bound and smallest runtime.

Instance		AMP	AMCF	GM	HBP	DD
energy_hotel_frame1frame71	UB	**-3969.29**	**-3969.29**	**-3969.29**	**-3969.29**	**-3969.29**
	LB	**-3969.29**	**-3969.29**	**-3969.29**	**-3969.29**	**-3969.29**
	runtime(s)	1.12	1.42	1.66	12.79	**0.98**
energy_hotel_frame1frame78	UB	**-3874.87**	**-3874.87**	**-3874.87**	**-3874.87**	**-3874.87**
	LB	**-3874.87**	**-3874.87**	**-3874.87**	**-3874.87**	**-3874.87**
	runtime(s)	2.41	6.18	39.91	51.40	**1.73**
energy_hotel_frame1frame8	UB	**-4570.58**	**-4570.58**	**-4570.58**	**-4570.58**	**-4570.58**
	LB	**-4570.58**	**-4570.58**	**-4570.58**	**-4570.58**	**-4570.58**
	runtime(s)	0.15	0.14	**0.02**	0.32	0.03
energy_hotel_frame1frame85	UB	**-3817.96**	**-3817.96**	**-3817.96**	**-3817.96**	**-3817.96**
	LB	**-3817.96**	**-3817.96**	**-3817.96**	-3820.37	**-3817.96**
	runtime(s)	4.67	6.83	87.48	180.26	**1.77**
energy_hotel_frame1frame92	UB	**-3728.34**	**-3728.34**	**-3728.34**	**-3728.34**	**-3728.34**
	LB	**-3728.34**	**-3728.34**	-3748.95	-3770.59	**-3728.34**
	runtime(s)	20.19	39.39	365.63	190.72	**2.34**
energy_hotel_frame1frame99	UB	**-3691.38**	**-3691.38**	-3497.74	-3486.96	**-3691.38**
	LB	**-3691.38**	**-3691.38**	-3741.70	-3777.32	**-3691.38**
	runtime(s)	152.97	264.53	299.78	192.51	**4.79**
energy_hotel_frame22frame29	UB	**-4615.38**	**-4615.38**	**-4615.38**	**-4615.38**	**-4615.38**
	LB	**-4615.38**	**-4615.38**	**-4615.38**	**-4615.38**	**-4615.38**
	runtime(s)	0.15	0.14	**0.02**	0.22	0.03
energy_hotel_frame22frame36	UB	**-4527.37**	**-4527.37**	**-4527.37**	**-4527.37**	**-4527.37**
	LB	**-4527.37**	**-4527.37**	**-4527.37**	**-4527.37**	**-4527.37**
	runtime(s)	0.15	0.14	**0.02**	0.32	0.03
energy_hotel_frame22frame43	UB	**-4428.42**	**-4428.42**	**-4428.42**	**-4428.42**	**-4428.42**
	LB	**-4428.42**	**-4428.42**	**-4428.42**	**-4428.42**	**-4428.42**
	runtime(s)	0.48	0.46	**0.02**	0.42	0.06
energy_hotel_frame22frame50	UB	**-4343.82**	**-4343.82**	**-4343.82**	**-4343.82**	**-4343.82**
	LB	**-4343.82**	**-4343.82**	**-4343.82**	**-4343.82**	**-4343.82**
	runtime(s)	0.48	0.46	0.13	0.42	**0.09**
energy_hotel_frame22frame57	UB	**-4302.35**	**-4302.35**	**-4302.35**	**-4302.35**	**-4302.35**
	LB	**-4302.35**	**-4302.35**	**-4302.35**	**-4302.35**	**-4302.35**
	runtime(s)	0.47	0.46	0.13	0.61	**0.07**
energy_hotel_frame22frame64	UB	**-4219.53**	**-4219.53**	**-4219.53**	**-4219.53**	**-4219.53**
	LB	**-4219.53**	**-4219.53**	**-4219.53**	**-4219.53**	**-4219.53**
	runtime(s)	0.47	0.46	0.13	0.91	**0.10**
energy_hotel_frame22frame71	UB	**-4188.30**	**-4188.30**	**-4188.30**	**-4188.30**	**-4188.30**
	LB	**-4188.30**	**-4188.30**	**-4188.30**	**-4188.30**	**-4188.30**
	runtime(s)	0.47	0.46	**0.24**	3.76	0.26
energy_hotel_frame22frame78	UB	**-4109.42**	**-4109.42**	**-4109.42**	**-4109.42**	**-4109.42**
	LB	**-4109.42**	**-4109.42**	**-4109.42**	**-4109.42**	**-4109.42**
	runtime(s)	0.80	0.78	0.35	4.79	**0.10**
energy_hotel_frame22frame85	UB	**-4063.39**	**-4063.39**	**-4063.39**	**-4063.39**	**-4063.39**
	LB	**-4063.39**	**-4063.39**	**-4063.39**	**-4063.39**	**-4063.39**
	runtime(s)	1.12	1.10	1.11	8.04	**0.37**
energy_hotel_frame22frame92	UB	**-3979.05**	**-3979.05**	**-3979.05**	**-3979.05**	**-3979.05**
	LB	**-3979.05**	**-3979.05**	**-3979.05**	**-3979.05**	**-3979.05**
	runtime(s)	1.44	2.05	11.54	23.91	**0.44**
energy_hotel_frame22frame99	UB	**-3956.74**	**-3956.74**	**-3956.74**	**-3956.74**	**-3956.74**
	LB	**-3956.74**	**-3956.74**	**-3956.74**	**-3956.74**	**-3956.74**
	runtime(s)	2.73	3.65	36.03	31.84	**0.67**
energy_hotel_frame29frame36	UB	**-4605.48**	**-4605.48**	**-4605.48**	**-4605.48**	**-4605.48**
	LB	**-4605.48**	**-4605.48**	**-4605.48**	**-4605.48**	**-4605.48**
	runtime(s)	0.15	0.14	**0.02**	0.42	0.02
energy_hotel_frame29frame43	UB	**-4493.70**	**-4493.70**	**-4493.70**	**-4493.70**	**-4493.70**
	LB	**-4493.70**	**-4493.70**	**-4493.70**	**-4493.70**	**-4493.70**
	runtime(s)	0.47	0.46	**0.02**	0.32	0.04
energy_hotel_frame29frame50	UB	**-4408.69**	**-4408.69**	**-4408.69**	**-4408.69**	**-4408.69**
	LB	**-4408.69**	**-4408.69**	**-4408.69**	**-4408.69**	**-4408.69**
	runtime(s)	0.48	0.46	0.13	0.42	**0.08**

Table 6: Per-instance results. UB means primal solution energy, LB dual lower bound and runtime(s) the runtime of the particular algorithm in seconds. **Bold numbers** indicate lowest primal energy, highest lower bound and smallest runtime.

Instance		AMP	AMCF	GM	HBP	DD
energy_hotel_frame29frame57	UB	**-4373.36**	**-4373.36**	**-4373.36**	**-4373.36**	**-4373.36**
	LB	**-4373.36**	**-4373.36**	**-4373.36**	**-4373.36**	**-4373.36**
	runtime(s)	0.47	0.46	0.13	0.52	**0.06**
energy_hotel_frame29frame64	UB	**-4295.62**	**-4295.62**	**-4295.62**	**-4295.62**	**-4295.62**
	LB	**-4295.62**	**-4295.62**	**-4295.62**	**-4295.62**	**-4295.62**
	runtime(s)	0.47	0.46	0.13	0.52	**0.07**
energy_hotel_frame29frame71	UB	**-4253.97**	**-4253.97**	**-4253.97**	**-4253.97**	**-4253.97**
	LB	**-4253.97**	**-4253.97**	**-4253.97**	**-4253.97**	**-4253.97**
	runtime(s)	0.48	0.46	0.13	0.71	**0.09**
energy_hotel_frame29frame78	UB	**-4167.70**	**-4167.70**	**-4167.70**	**-4167.70**	**-4167.70**
	LB	**-4167.70**	**-4167.70**	**-4167.70**	**-4167.70**	**-4167.70**
	runtime(s)	0.80	0.78	**0.24**	3.82	0.32
energy_hotel_frame29frame85	UB	**-4118.45**	**-4118.45**	**-4118.45**	**-4118.45**	**-4118.45**
	LB	**-4118.45**	**-4118.45**	**-4118.45**	**-4118.45**	**-4118.45**
	runtime(s)	0.80	0.78	0.35	2.09	**0.24**
energy_hotel_frame29frame92	UB	**-4037.12**	**-4037.12**	**-4037.12**	**-4037.12**	**-4037.12**
	LB	**-4037.12**	**-4037.12**	**-4037.12**	**-4037.12**	**-4037.12**
	runtime(s)	1.12	1.09	2.87	9.02	**0.34**
energy_hotel_frame29frame99	UB	**-4007.34**	**-4007.34**	**-4007.34**	**-4007.34**	**-4007.34**
	LB	**-4007.34**	**-4007.34**	**-4007.34**	**-4007.34**	**-4007.34**
	runtime(s)	1.77	2.05	14.45	21.69	**0.57**
energy_hotel_frame36frame43	UB	**-4571.30**	**-4571.30**	**-4571.30**	**-4571.30**	**-4571.30**
	LB	**-4571.30**	**-4571.30**	**-4571.30**	**-4571.30**	**-4571.30**
	runtime(s)	0.15	0.14	**0.02**	0.32	0.06
energy_hotel_frame36frame50	UB	**-4489.95**	**-4489.95**	**-4489.95**	**-4489.95**	**-4489.95**
	LB	**-4489.95**	**-4489.95**	**-4489.95**	**-4489.95**	**-4489.95**
	runtime(s)	0.15	0.46	0.13	0.42	**0.07**
energy_hotel_frame36frame57	UB	**-4451.32**	**-4451.32**	**-4451.32**	**-4451.32**	**-4451.32**
	LB	**-4451.32**	**-4451.32**	**-4451.32**	**-4451.32**	**-4451.32**
	runtime(s)	0.47	0.46	**0.02**	0.52	0.08
energy_hotel_frame36frame64	UB	**-4373.51**	**-4373.51**	**-4373.51**	**-4373.51**	**-4373.51**
	LB	**-4373.51**	**-4373.51**	**-4373.51**	**-4373.51**	**-4373.51**
	runtime(s)	0.47	0.47	0.13	0.52	**0.10**
energy_hotel_frame36frame71	UB	**-4326.74**	**-4326.74**	**-4326.74**	**-4326.74**	**-4326.74**
	LB	**-4326.74**	**-4326.74**	**-4326.74**	**-4326.74**	**-4326.74**
	runtime(s)	0.48	0.46	**0.13**	2.86	0.17
energy_hotel_frame36frame78	UB	**-4249.20**	**-4249.20**	**-4249.20**	**-4249.20**	**-4249.20**
	LB	**-4249.20**	**-4249.20**	**-4249.20**	**-4249.20**	**-4249.20**
	runtime(s)	0.47	0.46	0.13	3.65	**0.10**
energy_hotel_frame36frame85	UB	**-4192.38**	**-4192.38**	**-4192.38**	**-4192.38**	**-4192.38**
	LB	**-4192.38**	**-4192.38**	**-4192.38**	**-4192.38**	**-4192.38**
	runtime(s)	0.47	0.78	**0.24**	1.62	0.32
energy_hotel_frame36frame92	UB	**-4124.33**	**-4124.33**	**-4124.33**	**-4124.33**	**-4124.33**
	LB	**-4124.33**	**-4124.33**	**-4124.33**	**-4124.33**	**-4124.33**
	runtime(s)	0.81	0.78	0.79	6.90	**0.67**
energy_hotel_frame36frame99	UB	**-4094.55**	**-4094.55**	**-4094.55**	**-4094.55**	**-4094.55**
	LB	**-4094.55**	**-4094.55**	**-4094.55**	**-4094.55**	**-4094.55**
	runtime(s)	1.12	1.12	9.03	21.35	**0.78**
energy_hotel_frame43frame50	UB	**-4563.61**	**-4563.61**	**-4563.61**	**-4563.61**	**-4563.61**
	LB	**-4563.61**	**-4563.61**	**-4563.61**	**-4563.61**	**-4563.61**
	runtime(s)	0.15	0.14	**0.02**	0.33	0.09
energy_hotel_frame43frame57	UB	**-4532.17**	**-4532.17**	**-4532.17**	**-4532.17**	**-4532.17**
	LB	**-4532.17**	**-4532.17**	**-4532.17**	**-4532.17**	**-4532.17**
	runtime(s)	0.15	0.14	**0.02**	0.32	0.05
energy_hotel_frame43frame64	UB	**-4450.44**	**-4450.44**	**-4450.44**	**-4450.44**	**-4450.44**
	LB	**-4450.44**	**-4450.44**	**-4450.44**	**-4450.44**	**-4450.44**
	runtime(s)	0.47	0.46	0.13	0.42	**0.13**
energy_hotel_frame43frame71	UB	**-4422.17**	**-4422.17**	**-4422.17**	**-4422.17**	**-4422.17**
	LB	**-4422.17**	**-4422.17**	**-4422.17**	**-4422.17**	**-4422.17**
	runtime(s)	0.48	0.46	**0.13**	2.68	0.16

Table 6: Per-instance results. UB means primal solution energy, LB dual lower bound and runtime(s) the runtime of the particular algorithm in seconds. **Bold numbers** indicate lowest primal energy, highest lower bound and smallest runtime.

Instance		AMP	AMCF	GM	HBP	DD
energy_hotel_frame43frame78	UB	**-4351.89**	**-4351.89**	**-4351.89**	**-4351.89**	**-4351.89**
	LB	**-4351.89**	**-4351.89**	**-4351.89**	**-4351.89**	**-4351.89**
	runtime(s)	0.48	0.46	0.13	0.71	**0.10**
energy_hotel_frame43frame85	UB	**-4295.89**	**-4295.89**	**-4295.89**	**-4295.89**	**-4295.89**
	LB	**-4295.89**	**-4295.89**	**-4295.89**	**-4295.89**	**-4295.89**
	runtime(s)	0.48	0.46	**0.13**	0.82	0.24
energy_hotel_frame43frame92	UB	**-4221.52**	**-4221.52**	**-4221.52**	**-4221.52**	**-4221.52**
	LB	**-4221.52**	**-4221.52**	**-4221.52**	**-4221.52**	**-4221.52**
	runtime(s)	0.80	0.78	0.24	3.58	**0.13**
energy_hotel_frame43frame99	UB	**-4190.13**	**-4190.13**	**-4190.13**	**-4190.13**	**-4190.13**
	LB	**-4190.13**	**-4190.13**	**-4190.13**	**-4190.13**	**-4190.13**
	runtime(s)	0.80	0.78	0.35	5.01	**0.34**
energy_hotel_frame50frame57	UB	**-4566.79**	**-4566.79**	**-4566.79**	**-4566.79**	**-4566.79**
	LB	**-4566.79**	**-4566.79**	**-4566.79**	**-4566.79**	**-4566.79**
	runtime(s)	0.15	0.14	**0.02**	0.41	0.05
energy_hotel_frame50frame64	UB	**-4517.31**	**-4517.31**	**-4517.31**	**-4517.31**	**-4517.31**
	LB	**-4517.31**	**-4517.31**	**-4517.31**	**-4517.31**	**-4517.31**
	runtime(s)	0.47	0.46	**0.02**	0.42	0.06
energy_hotel_frame50frame71	UB	**-4463.52**	**-4463.52**	**-4463.52**	**-4463.52**	**-4463.52**
	LB	**-4463.52**	**-4463.52**	**-4463.52**	**-4463.52**	**-4463.52**
	runtime(s)	0.47	0.46	0.13	0.52	**0.10**
energy_hotel_frame50frame78	UB	**-4400.83**	**-4400.83**	**-4400.83**	**-4400.83**	**-4400.83**
	LB	**-4400.83**	**-4400.83**	**-4400.83**	**-4400.83**	**-4400.83**
	runtime(s)	0.48	0.46	0.14	0.52	**0.12**
energy_hotel_frame50frame85	UB	**-4342.35**	**-4342.35**	**-4342.35**	**-4342.35**	**-4342.35**
	LB	**-4342.35**	**-4342.35**	**-4342.35**	**-4342.35**	**-4342.35**
	runtime(s)	0.47	0.46	**0.13**	0.72	0.15
energy_hotel_frame50frame92	UB	**-4260.01**	**-4260.01**	**-4260.01**	**-4260.01**	**-4260.01**
	LB	**-4260.01**	**-4260.01**	**-4260.01**	**-4260.01**	**-4260.01**
	runtime(s)	0.47	0.46	0.24	3.36	**0.17**
energy_hotel_frame50frame99	UB	**-4240.95**	**-4240.95**	**-4240.95**	**-4240.95**	**-4240.95**
	LB	**-4240.95**	**-4240.95**	**-4240.95**	**-4240.95**	**-4240.95**
	runtime(s)	0.80	0.46	0.24	4.63	**0.14**
energy_hotel_frame57frame64	UB	**-4567.13**	**-4567.13**	**-4567.13**	**-4567.13**	**-4567.13**
	LB	**-4567.13**	**-4567.13**	**-4567.13**	**-4567.13**	**-4567.13**
	runtime(s)	0.15	0.14	**0.02**	0.32	0.07
energy_hotel_frame57frame71	UB	**-4508.58**	**-4508.58**	**-4508.58**	**-4508.58**	**-4508.58**
	LB	**-4508.58**	**-4508.58**	**-4508.58**	**-4508.58**	**-4508.58**
	runtime(s)	0.15	0.15	**0.02**	0.32	0.11
energy_hotel_frame57frame78	UB	**-4475.54**	**-4475.54**	**-4475.54**	**-4475.54**	**-4475.54**
	LB	**-4475.54**	**-4475.54**	**-4475.54**	**-4475.54**	**-4475.54**
	runtime(s)	0.48	0.46	**0.13**	0.42	**0.13**
energy_hotel_frame57frame85	UB	**-4398.90**	**-4398.90**	**-4398.90**	**-4398.90**	**-4398.90**
	LB	**-4398.90**	**-4398.90**	**-4398.90**	**-4398.90**	**-4398.90**
	runtime(s)	0.48	0.46	**0.13**	0.62	0.19
energy_hotel_frame57frame92	UB	**-4344.52**	**-4344.52**	**-4344.52**	**-4344.52**	**-4344.52**
	LB	**-4344.52**	**-4344.52**	**-4344.52**	**-4344.52**	**-4344.52**
	runtime(s)	0.48	0.46	0.13	0.92	**0.12**
energy_hotel_frame57frame99	UB	**-4332.33**	**-4332.33**	**-4332.33**	**-4332.33**	**-4332.33**
	LB	**-4332.33**	**-4332.33**	**-4332.33**	**-4332.33**	**-4332.33**
	runtime(s)	0.48	0.46	**0.13**	3.06	0.23
energy_hotel_frame64frame71	UB	**-4578.65**	**-4578.65**	**-4578.65**	**-4578.65**	**-4578.65**
	LB	**-4578.65**	**-4578.65**	**-4578.65**	**-4578.65**	**-4578.65**
	runtime(s)	0.15	0.14	**0.02**	0.32	0.07
energy_hotel_frame64frame78	UB	**-4545.63**	**-4545.63**	**-4545.63**	**-4545.63**	**-4545.63**
	LB	**-4545.63**	**-4545.63**	**-4545.63**	**-4545.63**	**-4545.63**
	runtime(s)	0.47	0.14	**0.02**	0.41	0.07
energy_hotel_frame64frame85	UB	**-4481.13**	**-4481.13**	**-4481.13**	**-4481.13**	**-4481.13**
	LB	**-4481.13**	**-4481.13**	**-4481.13**	**-4481.13**	**-4481.13**
	runtime(s)	0.47	0.46	0.13	0.51	**0.10**

Table 6: Per-instance results. UB means primal solution energy, LB dual lower bound and runtime(s) the runtime of the particular algorithm in seconds. **Bold numbers** indicate lowest primal energy, highest lower bound and smallest runtime.

Instance		AMP	AMCF	GM	HBP	DD
energy_hotel_frame64frame92	UB	**-4413.01**	**-4413.01**	**-4413.01**	**-4413.01**	**-4413.01**
	LB	**-4413.01**	**-4413.01**	**-4413.01**	**-4413.01**	**-4413.01**
	runtime(s)	0.47	0.46	0.13	0.61	**0.09**
energy_hotel_frame64frame99	UB	**-4385.51**	**-4385.51**	**-4385.51**	**-4385.51**	**-4385.51**
	LB	**-4385.51**	**-4385.51**	**-4385.51**	**-4385.51**	**-4385.51**
	runtime(s)	0.47	0.46	0.13	0.81	**0.11**
energy_hotel_frame71frame78	UB	**-4550.95**	**-4550.95**	**-4550.95**	**-4550.95**	**-4550.95**
	LB	**-4550.95**	**-4550.95**	**-4550.95**	**-4550.95**	**-4550.95**
	runtime(s)	0.48	0.46	**0.03**	0.42	0.10
energy_hotel_frame71frame85	UB	**-4552.71**	**-4552.71**	**-4552.71**	**-4552.71**	**-4552.71**
	LB	**-4552.71**	**-4552.71**	**-4552.71**	**-4552.71**	**-4552.71**
	runtime(s)	0.15	0.14	**0.02**	0.41	0.17
energy_hotel_frame71frame92	UB	**-4469.72**	**-4469.72**	**-4469.72**	**-4469.72**	**-4469.72**
	LB	**-4469.72**	**-4469.72**	**-4469.72**	**-4469.72**	**-4469.72**
	runtime(s)	0.48	0.46	0.13	0.52	**0.10**
energy_hotel_frame71frame99	UB	**-4413.34**	**-4413.34**	**-4413.34**	**-4413.34**	**-4413.34**
	LB	**-4413.34**	**-4413.34**	**-4413.34**	**-4413.34**	**-4413.34**
	runtime(s)	0.47	0.46	**0.13**	0.52	0.17
energy_hotel_frame78frame85	UB	**-4589.16**	**-4589.16**	**-4589.16**	**-4589.16**	**-4589.16**
	LB	**-4589.16**	**-4589.16**	**-4589.16**	**-4589.16**	**-4589.16**
	runtime(s)	0.48	0.14	**0.02**	0.52	0.09
energy_hotel_frame78frame92	UB	**-4545.04**	**-4545.04**	**-4545.04**	**-4545.04**	**-4545.04**
	LB	**-4545.04**	**-4545.04**	**-4545.04**	**-4545.04**	**-4545.04**
	runtime(s)	0.15	0.14	**0.02**	0.41	0.10
energy_hotel_frame78frame99	UB	**-4534.77**	**-4534.77**	**-4534.77**	**-4534.77**	**-4534.77**
	LB	**-4534.77**	**-4534.77**	**-4534.77**	**-4534.77**	**-4534.77**
	runtime(s)	0.15	0.14	**0.02**	0.42	0.08
energy_hotel_frame85frame92	UB	**-4578.16**	**-4578.16**	**-4578.16**	**-4578.16**	**-4578.16**
	LB	**-4578.16**	**-4578.16**	**-4578.16**	**-4578.16**	**-4578.16**
	runtime(s)	0.15	0.14	**0.02**	0.32	0.07
energy_hotel_frame85frame99	UB	**-4528.32**	**-4528.32**	**-4528.32**	**-4528.32**	**-4528.32**
	LB	**-4528.32**	**-4528.32**	**-4528.32**	**-4528.32**	**-4528.32**
	runtime(s)	0.47	0.46	**0.02**	0.41	0.14
energy_hotel_frame8frame15	UB	**-4572.64**	**-4572.64**	**-4572.64**	**-4572.64**	**-4572.64**
	LB	**-4572.64**	**-4572.64**	**-4572.64**	**-4572.64**	**-4572.64**
	runtime(s)	0.15	0.14	**0.02**	0.22	0.05
energy_hotel_frame8frame22	UB	**-4491.45**	**-4491.45**	**-4491.45**	**-4491.45**	**-4491.45**
	LB	**-4491.45**	**-4491.45**	**-4491.45**	**-4491.45**	**-4491.45**
	runtime(s)	0.47	0.14	**0.02**	0.32	0.05
energy_hotel_frame8frame29	UB	**-4424.96**	**-4424.96**	**-4424.96**	**-4424.96**	**-4424.96**
	LB	**-4424.96**	**-4424.96**	**-4424.96**	**-4424.96**	**-4424.96**
	runtime(s)	0.47	0.48	0.13	2.48	**0.07**
energy_hotel_frame8frame36	UB	**-4379.36**	**-4379.36**	**-4379.36**	**-4379.36**	**-4379.36**
	LB	**-4379.36**	**-4379.36**	**-4379.36**	**-4379.36**	**-4379.36**
	runtime(s)	0.48	0.49	0.13	0.52	**0.09**
energy_hotel_frame8frame43	UB	**-4262.09**	**-4262.09**	**-4262.09**	**-4262.09**	**-4262.09**
	LB	**-4262.09**	**-4262.09**	**-4262.09**	**-4262.09**	**-4262.09**
	runtime(s)	0.48	0.46	**0.13**	1.12	0.23
energy_hotel_frame8frame50	UB	**-4179.32**	**-4179.32**	**-4179.32**	**-4179.32**	**-4179.32**
	LB	**-4179.32**	**-4179.32**	**-4179.32**	**-4179.32**	**-4179.32**
	runtime(s)	0.48	0.47	**0.13**	1.34	0.24
energy_hotel_frame8frame57	UB	**-4131.18**	**-4131.18**	**-4131.18**	**-4131.18**	**-4131.18**
	LB	**-4131.18**	**-4131.18**	**-4131.18**	**-4131.18**	**-4131.18**
	runtime(s)	0.81	0.78	**0.24**	3.57	0.40
energy_hotel_frame8frame64	UB	**-4060.05**	**-4060.05**	**-4060.05**	**-4060.05**	**-4060.05**
	LB	**-4060.05**	**-4060.05**	**-4060.05**	**-4060.05**	**-4060.05**
	runtime(s)	0.80	0.79	**0.35**	4.45	0.94
energy_hotel_frame8frame71	UB	**-4021.39**	**-4021.39**	**-4021.39**	**-4021.39**	**-4021.39**
	LB	**-4021.39**	**-4021.39**	**-4021.39**	**-4021.39**	**-4021.39**
	runtime(s)	1.12	1.10	0.79	10.87	**0.58**

Table 6: Per-instance results. UB means primal solution energy, LB dual lower bound and runtime(s) the runtime of the particular algorithm in seconds. **Bold numbers** indicate lowest primal energy, highest lower bound and smallest runtime.

Instance		AMP	AMCF	GM	HBP	DD
energy_hotel_frame8frame78	UB	**-3931.28**	**-3931.28**	**-3931.28**	**-3931.28**	**-3931.28**
	LB	**-3931.28**	**-3931.28**	**-3931.28**	**-3931.28**	**-3931.28**
	runtime(s)	2.42	3.03	28.11	28.70	**1.78**
energy_hotel_frame8frame85	UB	**-3877.57**	**-3877.57**	**-3877.57**	**-3877.57**	**-3877.57**
	LB	**-3877.57**	**-3877.57**	**-3877.57**	**-3877.57**	**-3877.57**
	runtime(s)	3.73	6.54	43.07	140.69	**2.55**
energy_hotel_frame8frame92	UB	**-3802.05**	**-3802.05**	**-3802.05**	**-3802.05**	**-3802.05**
	LB	**-3802.05**	**-3802.05**	**-3802.05**	-3816.65	**-3802.05**
	runtime(s)	14.01	16.47	105.07	190.19	**2.82**
energy_hotel_frame8frame99	UB	**-3762.66**	**-3762.66**	-3654.00	-3337.29	**-3762.66**
	LB	**-3762.66**	**-3762.66**	-3790.14	-3815.80	**-3762.66**
	runtime(s)	54.33	39.25	294.09	191.97	**4.86**
energy_hotel_frame92frame99	UB	**-4593.17**	**-4593.17**	**-4593.17**	**-4593.17**	**-4593.17**
	LB	**-4593.17**	**-4593.17**	**-4593.17**	**-4593.17**	**-4593.17**
	runtime(s)	0.15	0.14	**0.02**	0.31	0.06
	house					
energy_house_frame10frame100	UB	**-3720.20**	**-3720.20**	**-3720.20**	**-3720.20**	**-3720.20**
	LB	**-3720.20**	**-3720.20**	**-3720.20**	**-3720.20**	**-3720.20**
	runtime(s)	7.25	6.19	2.75	21.87	**2.53**
energy_house_frame10frame95	UB	**-3809.38**	**-3809.38**	**-3809.38**	**-3809.38**	**-3809.38**
	LB	**-3809.38**	**-3809.38**	**-3809.38**	**-3809.38**	**-3809.38**
	runtime(s)	2.08	2.69	**1.01**	8.79	1.98
energy_house_frame10frame96	UB	**-3786.86**	**-3786.86**	**-3786.86**	**-3786.86**	**-3786.86**
	LB	**-3786.86**	**-3786.86**	**-3786.86**	**-3786.86**	**-3786.86**
	runtime(s)	2.08	2.36	**1.01**	9.27	2.66
energy_house_frame10frame97	UB	**-3748.34**	**-3748.34**	**-3748.34**	**-3748.34**	**-3748.34**
	LB	**-3748.34**	**-3748.34**	**-3748.34**	**-3748.34**	**-3748.34**
	runtime(s)	2.41	3.35	**1.23**	16.16	2.48
energy_house_frame10frame98	UB	**-3766.04**	**-3766.04**	**-3766.04**	**-3766.04**	**-3766.04**
	LB	**-3766.04**	**-3766.04**	**-3766.04**	**-3766.04**	**-3766.04**
	runtime(s)	2.73	3.33	**1.01**	9.16	2.07
energy_house_frame10frame99	UB	**-3728.46**	**-3728.46**	**-3728.46**	**-3728.46**	**-3728.46**
	LB	**-3728.46**	**-3728.46**	**-3728.46**	**-3728.46**	**-3728.46**
	runtime(s)	3.38	3.32	**1.55**	31.91	3.25
energy_house_frame11frame100	UB	**-3739.39**	**-3739.39**	**-3739.39**	**-3739.39**	**-3739.39**
	LB	**-3739.39**	**-3739.39**	**-3739.39**	**-3739.39**	**-3739.39**
	runtime(s)	4.02	4.91	**1.88**	16.19	2.54
energy_house_frame11frame101	UB	**-3748.61**	**-3748.61**	**-3748.61**	**-3748.61**	**-3748.61**
	LB	**-3748.61**	**-3748.61**	**-3748.61**	**-3748.61**	**-3748.61**
	runtime(s)	2.44	3.01	**1.34**	12.87	2.90
energy_house_frame11frame96	UB	**-3809.96**	**-3809.96**	**-3809.96**	**-3809.96**	**-3809.96**
	LB	**-3809.96**	**-3809.96**	**-3809.96**	**-3809.96**	**-3809.96**
	runtime(s)	1.76	2.37	**1.12**	8.69	2.19
energy_house_frame11frame97	UB	**-3748.31**	**-3748.31**	**-3748.31**	**-3748.31**	**-3748.31**
	LB	**-3748.31**	**-3748.31**	**-3748.31**	**-3748.31**	**-3748.31**
	runtime(s)	2.41	3.00	**1.12**	12.91	1.63
energy_house_frame11frame98	UB	**-3781.51**	**-3781.51**	**-3781.51**	**-3781.51**	**-3781.51**
	LB	**-3781.51**	**-3781.51**	**-3781.51**	**-3781.51**	**-3781.51**
	runtime(s)	2.42	3.32	**0.79**	6.22	2.27
energy_house_frame11frame99	UB	**-3736.47**	**-3736.47**	**-3736.47**	**-3736.47**	**-3736.47**
	LB	**-3736.47**	**-3736.47**	**-3736.47**	**-3736.47**	**-3736.47**
	runtime(s)	2.73	3.32	**1.22**	18.07	2.54
energy_house_frame12frame100	UB	**-3768.48**	**-3768.48**	**-3768.48**	**-3768.48**	**-3768.48**
	LB	**-3768.48**	**-3768.48**	**-3768.48**	**-3768.48**	**-3768.48**
	runtime(s)	6.60	5.53	5.37	24.18	**2.38**
energy_house_frame12frame101	UB	**-3775.50**	**-3775.50**	**-3775.50**	**-3775.50**	**-3775.50**
	LB	**-3775.50**	**-3775.50**	**-3775.50**	**-3775.50**	**-3775.50**
	runtime(s)	4.67	3.62	**1.77**	28.85	2.71
energy_house_frame12frame102	UB	**-3783.42**	**-3783.42**	**-3783.42**	**-3783.42**	**-3783.42**
	LB	**-3783.42**	**-3783.42**	**-3783.42**	**-3783.42**	**-3783.42**
	runtime(s)	3.37	3.01	**1.01**	8.71	2.62

Table 6: Per-instance results. UB means primal solution energy, LB dual lower bound and runtime(s) the runtime of the particular algorithm in seconds. **Bold numbers** indicate lowest primal energy, highest lower bound and smallest runtime.

Instance		AMP	AMCF	GM	HBP	DD
energy_house_frame12frame97	UB	**-3780.35**	**-3780.35**	**-3780.35**	**-3780.35**	**-3780.35**
	LB	**-3780.35**	**-3780.35**	**-3780.35**	**-3780.35**	**-3780.35**
	runtime(s)	3.05	2.99	**1.45**	15.89	2.68
energy_house_frame12frame98	UB	**-3807.50**	**-3807.50**	**-3807.50**	**-3807.50**	**-3807.50**
	LB	**-3807.50**	**-3807.50**	**-3807.50**	**-3807.50**	**-3807.50**
	runtime(s)	3.06	3.02	**1.11**	9.30	1.76
energy_house_frame12frame99	UB	**-3766.79**	**-3766.79**	**-3766.79**	**-3766.79**	**-3766.79**
	LB	**-3766.79**	**-3766.79**	**-3766.79**	**-3766.79**	**-3766.79**
	runtime(s)	4.34	3.31	**1.89**	28.90	2.49
energy_house_frame13frame100	UB	**-3749.52**	**-3749.52**	**-3749.52**	**-3749.52**	**-3749.52**
	LB	**-3749.52**	**-3749.52**	**-3749.52**	**-3749.52**	**-3749.52**
	runtime(s)	4.34	4.26	2.66	46.79	**2.44**
energy_house_frame13frame101	UB	**-3773.17**	**-3773.17**	**-3773.17**	**-3773.17**	**-3773.17**
	LB	**-3773.17**	**-3773.17**	**-3773.17**	**-3773.17**	**-3773.17**
	runtime(s)	2.73	2.35	**1.33**	18.01	2.78
energy_house_frame13frame102	UB	**-3775.96**	**-3775.96**	**-3775.96**	**-3775.96**	**-3775.96**
	LB	**-3775.96**	**-3775.96**	**-3775.96**	**-3775.96**	**-3775.96**
	runtime(s)	2.42	2.35	**1.01**	5.60	2.62
energy_house_frame13frame103	UB	**-3749.50**	**-3749.50**	**-3749.50**	**-3749.50**	**-3749.50**
	LB	**-3749.50**	**-3749.50**	**-3749.50**	**-3749.50**	**-3749.50**
	runtime(s)	2.41	2.68	**1.12**	17.98	2.61
energy_house_frame13frame98	UB	**-3798.88**	**-3798.88**	**-3798.88**	**-3798.88**	**-3798.88**
	LB	**-3798.88**	**-3798.88**	**-3798.88**	**-3798.88**	**-3798.88**
	runtime(s)	2.08	2.68	**1.01**	6.64	2.45
energy_house_frame13frame99	UB	**-3754.97**	**-3754.97**	**-3754.97**	**-3754.97**	**-3754.97**
	LB	**-3754.97**	**-3754.97**	**-3754.97**	**-3754.97**	**-3754.97**
	runtime(s)	2.73	2.36	**1.45**	13.06	2.36
energy_house_frame14frame100	UB	**-3785.20**	**-3785.20**	**-3785.20**	**-3785.20**	**-3785.20**
	LB	**-3785.20**	**-3785.20**	**-3785.20**	**-3785.20**	**-3785.20**
	runtime(s)	5.63	4.25	6.35	31.82	**2.92**
energy_house_frame14frame101	UB	**-3796.54**	**-3796.54**	**-3796.54**	**-3796.54**	**-3796.54**
	LB	**-3796.54**	**-3796.54**	**-3796.54**	**-3796.54**	**-3796.54**
	runtime(s)	4.01	3.32	**1.55**	12.88	2.68
energy_house_frame14frame102	UB	**-3806.95**	**-3806.95**	**-3806.95**	**-3806.95**	**-3806.95**
	LB	**-3806.95**	**-3806.95**	**-3806.95**	**-3806.95**	**-3806.95**
	runtime(s)	2.73	2.67	**1.22**	8.27	2.56
energy_house_frame14frame103	UB	**-3769.12**	**-3769.12**	**-3769.12**	**-3769.12**	**-3769.12**
	LB	**-3769.12**	**-3769.12**	**-3769.12**	**-3769.12**	**-3769.12**
	runtime(s)	3.06	2.99	**1.35**	12.88	3.29
energy_house_frame14frame104	UB	**-3761.22**	**-3761.22**	**-3761.22**	**-3761.22**	**-3761.22**
	LB	**-3761.22**	**-3761.22**	**-3761.22**	**-3761.22**	**-3761.22**
	runtime(s)	4.99	4.57	6.66	37.48	**2.92**
energy_house_frame14frame99	UB	**-3788.42**	**-3788.42**	**-3788.42**	**-3788.42**	**-3788.42**
	LB	**-3788.42**	**-3788.42**	**-3788.42**	**-3788.42**	**-3788.42**
	runtime(s)	3.69	2.68	**1.55**	14.36	2.65
energy_house_frame15frame100	UB	**-3784.87**	**-3784.87**	**-3784.87**	**-3784.87**	**-3784.87**
	LB	**-3784.87**	**-3784.87**	**-3784.87**	**-3784.87**	**-3784.87**
	runtime(s)	3.05	3.31	**1.23**	16.19	2.27
energy_house_frame15frame101	UB	**-3796.63**	**-3796.63**	**-3796.63**	**-3796.63**	**-3796.63**
	LB	**-3796.63**	**-3796.63**	**-3796.63**	**-3796.63**	**-3796.63**
	runtime(s)	2.09	2.36	**0.79**	8.64	2.19
energy_house_frame15frame102	UB	**-3798.54**	**-3798.54**	**-3798.54**	**-3798.54**	**-3798.54**
	LB	**-3798.54**	**-3798.54**	**-3798.54**	**-3798.54**	**-3798.54**
	runtime(s)	2.09	2.04	**0.57**	5.66	2.03
energy_house_frame15frame103	UB	**-3774.99**	**-3774.99**	**-3774.99**	**-3774.99**	**-3774.99**
	LB	**-3774.99**	**-3774.99**	**-3774.99**	**-3774.99**	**-3774.99**
	runtime(s)	2.09	2.69	**0.68**	12.87	1.98
energy_house_frame15frame104	UB	**-3762.50**	**-3762.50**	**-3762.50**	**-3762.50**	**-3762.50**
	LB	**-3762.50**	**-3762.50**	**-3762.50**	**-3762.50**	**-3762.50**
	runtime(s)	3.05	3.62	**1.67**	17.90	3.07

Table 6: Per-instance results. UB means primal solution energy, LB dual lower bound and runtime(s) the runtime of the particular algorithm in seconds. **Bold numbers** indicate lowest primal energy, highest lower bound and smallest runtime.

Instance		AMP	AMCF	GM	HBP	DD
energy_house_frame15frame105	UB	**-3745.16**	**-3745.16**	**-3745.16**	**-3745.16**	**-3745.16**
	LB	**-3745.16**	**-3745.16**	**-3745.16**	**-3745.16**	**-3745.16**
	runtime(s)	2.41	3.62	**0.90**	9.21	2.09
energy_house_frame16frame101	UB	**-3804.83**	**-3804.83**	**-3804.83**	**-3804.83**	**-3804.83**
	LB	**-3804.83**	**-3804.83**	**-3804.83**	**-3804.83**	**-3804.83**
	runtime(s)	1.76	2.36	4.38	9.34	**1.44**
energy_house_frame16frame102	UB	**-3815.11**	**-3815.11**	**-3815.11**	**-3815.11**	**-3815.11**
	LB	**-3815.11**	**-3815.11**	**-3815.11**	**-3815.11**	**-3815.11**
	runtime(s)	1.77	1.73	**0.68**	6.15	1.40
energy_house_frame16frame103	UB	**-3787.76**	**-3787.76**	**-3787.76**	**-3787.76**	**-3787.76**
	LB	**-3787.76**	**-3787.76**	**-3787.76**	**-3787.76**	**-3787.76**
	runtime(s)	1.76	2.05	**0.78**	8.06	2.01
energy_house_frame16frame104	UB	**-3774.51**	**-3774.51**	**-3774.51**	**-3774.51**	**-3774.51**
	LB	**-3774.51**	**-3774.51**	**-3774.51**	**-3774.51**	**-3774.51**
	runtime(s)	2.41	2.99	6.07	18.36	**1.83**
energy_house_frame16frame105	UB	**-3752.97**	**-3752.97**	**-3752.97**	**-3752.97**	**-3752.97**
	LB	**-3752.97**	**-3752.97**	**-3752.97**	**-3752.97**	**-3752.97**
	runtime(s)	2.09	2.99	4.81	12.93	**1.62**
energy_house_frame17frame102	UB	**-3820.84**	**-3820.84**	**-3820.84**	**-3820.84**	**-3820.84**
	LB	**-3820.84**	**-3820.84**	**-3820.84**	**-3820.84**	**-3820.84**
	runtime(s)	1.44	1.73	**0.46**	3.32	1.34
energy_house_frame17frame103	UB	**-3799.56**	**-3799.56**	**-3799.56**	**-3799.56**	**-3799.56**
	LB	**-3799.56**	**-3799.56**	**-3799.56**	**-3799.56**	**-3799.56**
	runtime(s)	1.77	2.04	**0.57**	6.48	1.97
energy_house_frame17frame104	UB	**-3774.96**	**-3774.96**	**-3774.96**	**-3774.96**	**-3774.96**
	LB	**-3774.96**	**-3774.96**	**-3774.96**	**-3774.96**	**-3774.96**
	runtime(s)	2.09	2.36	**1.11**	12.83	1.93
energy_house_frame17frame105	UB	**-3756.27**	**-3756.27**	**-3756.27**	**-3756.27**	**-3756.27**
	LB	**-3756.27**	**-3756.27**	**-3756.27**	**-3756.27**	**-3756.27**
	runtime(s)	2.41	2.99	**0.79**	9.35	2.97
energy_house_frame18frame103	UB	**-3821.69**	**-3821.69**	**-3821.69**	**-3821.69**	**-3821.69**
	LB	**-3821.69**	**-3821.69**	**-3821.69**	**-3821.69**	**-3821.69**
	runtime(s)	2.41	2.36	**0.90**	12.89	1.81
energy_house_frame18frame104	UB	**-3794.07**	**-3794.07**	**-3794.07**	**-3794.07**	**-3794.07**
	LB	**-3794.07**	**-3794.07**	**-3794.07**	**-3794.07**	**-3794.07**
	runtime(s)	3.38	3.64	**2.10**	24.01	2.99
energy_house_frame18frame105	UB	**-3777.39**	**-3777.39**	**-3777.39**	**-3777.39**	**-3777.39**
	LB	**-3777.39**	**-3777.39**	**-3777.39**	**-3777.39**	**-3777.39**
	runtime(s)	2.72	2.99	**1.12**	17.78	2.39
energy_house_frame19frame104	UB	**-3799.19**	**-3799.19**	**-3799.19**	**-3799.19**	**-3799.19**
	LB	**-3799.19**	**-3799.19**	**-3799.19**	**-3799.19**	**-3799.19**
	runtime(s)	3.37	3.50	**2.21**	12.89	3.46
energy_house_frame19frame105	UB	**-3767.45**	**-3767.45**	**-3767.45**	**-3767.45**	**-3767.45**
	LB	**-3767.45**	**-3767.45**	**-3767.45**	**-3767.45**	**-3767.45**
	runtime(s)	3.08	2.68	**1.45**	24.10	2.33
energy_house_frame1frame86	UB	**-3833.13**	**-3833.13**	**-3833.13**	**-3833.13**	**-3833.13**
	LB	**-3833.13**	**-3833.13**	**-3833.13**	**-3833.13**	**-3833.13**
	runtime(s)	1.44	1.41	**0.35**	2.72	1.74
energy_house_frame1frame87	UB	**-3808.48**	**-3808.48**	**-3808.48**	**-3808.48**	**-3808.48**
	LB	**-3808.48**	**-3808.48**	**-3808.48**	**-3808.48**	**-3808.48**
	runtime(s)	1.44	1.10	**0.46**	4.38	1.60
energy_house_frame1frame88	UB	**-3758.22**	**-3758.22**	**-3758.22**	**-3758.22**	**-3758.22**
	LB	**-3758.22**	**-3758.22**	**-3758.22**	**-3758.22**	**-3758.22**
	runtime(s)	1.76	1.92	**0.68**	7.04	2.06
energy_house_frame1frame89	UB	**-3776.74**	**-3776.74**	**-3776.74**	**-3776.74**	**-3776.74**
	LB	**-3776.74**	**-3776.74**	**-3776.74**	**-3776.74**	**-3776.74**
	runtime(s)	2.09	2.04	**0.68**	8.37	2.31
energy_house_frame1frame90	UB	**-3710.78**	**-3710.78**	**-3710.78**	**-3710.78**	**-3710.78**
	LB	**-3710.78**	**-3710.78**	**-3710.78**	**-3710.78**	**-3710.78**
	runtime(s)	2.40	2.04	**1.78**	56.87	3.92

Table 6: Per-instance results. UB means primal solution energy, LB dual lower bound and runtime(s) the runtime of the particular algorithm in seconds. **Bold numbers** indicate lowest primal energy, highest lower bound and smallest runtime.

Instance		AMP	AMCF	GM	HBP	DD
energy_house_frame1frame91	UB	**-3761.74**	**-3761.74**	**-3761.74**	**-3761.74**	**-3761.74**
	LB	**-3761.74**	**-3761.74**	**-3761.74**	**-3761.74**	**-3761.74**
	runtime(s)	2.08	2.36	**0.79**	5.97	2.66
energy_house_frame20frame105	UB	**-3772.12**	**-3772.12**	**-3772.12**	**-3772.12**	**-3772.12**
	LB	**-3772.12**	**-3772.12**	**-3772.12**	**-3772.12**	**-3772.12**
	runtime(s)	2.40	2.68	**0.90**	9.59	2.50
energy_house_frame2frame87	UB	**-3837.08**	**-3837.08**	**-3837.08**	**-3837.08**	**-3837.08**
	LB	**-3837.08**	**-3837.08**	**-3837.08**	**-3837.08**	**-3837.08**
	runtime(s)	1.44	1.10	**0.35**	2.01	1.32
energy_house_frame2frame88	UB	**-3807.53**	**-3807.53**	**-3807.53**	**-3807.53**	**-3807.53**
	LB	**-3807.53**	**-3807.53**	**-3807.53**	**-3807.53**	**-3807.53**
	runtime(s)	1.44	2.04	**0.46**	5.97	1.69
energy_house_frame2frame89	UB	**-3807.82**	**-3807.82**	**-3807.82**	**-3807.82**	**-3807.82**
	LB	**-3807.82**	**-3807.82**	**-3807.82**	**-3807.82**	**-3807.82**
	runtime(s)	1.76	2.06	**0.68**	7.47	2.05
energy_house_frame2frame90	UB	**-3766.17**	**-3766.17**	**-3766.17**	**-3766.17**	**-3766.17**
	LB	**-3766.17**	**-3766.17**	**-3766.17**	**-3766.17**	**-3766.17**
	runtime(s)	2.08	2.36	**1.00**	16.25	1.72
energy_house_frame2frame91	UB	**-3791.43**	**-3791.43**	**-3791.43**	**-3791.43**	**-3791.43**
	LB	**-3791.43**	**-3791.43**	**-3791.43**	**-3791.43**	**-3791.43**
	runtime(s)	1.76	2.67	**0.81**	6.42	2.12
energy_house_frame2frame92	UB	**-3753.22**	**-3753.22**	**-3753.22**	**-3753.22**	**-3753.22**
	LB	**-3753.22**	**-3753.22**	**-3753.22**	**-3753.22**	**-3753.22**
	runtime(s)	2.73	3.31	**1.01**	16.13	1.56
energy_house_frame3frame88	UB	**-3808.14**	**-3808.14**	**-3808.14**	**-3808.14**	**-3808.14**
	LB	**-3808.14**	**-3808.14**	**-3808.14**	**-3808.14**	**-3808.14**
	runtime(s)	1.76	2.04	**0.68**	7.18	1.95
energy_house_frame3frame89	UB	**-3815.26**	**-3815.26**	**-3815.26**	**-3815.26**	**-3815.26**
	LB	**-3815.26**	**-3815.26**	**-3815.26**	**-3815.26**	**-3815.26**
	runtime(s)	2.40	2.36	**0.68**	7.58	2.06
energy_house_frame3frame90	UB	**-3761.33**	**-3761.33**	**-3761.33**	**-3761.33**	**-3761.33**
	LB	**-3761.33**	**-3761.33**	**-3761.33**	**-3761.33**	**-3761.33**
	runtime(s)	2.41	2.68	**1.22**	24.28	2.13
energy_house_frame3frame91	UB	**-3808.47**	**-3808.47**	**-3808.47**	**-3808.47**	**-3808.47**
	LB	**-3808.47**	**-3808.47**	**-3808.47**	**-3808.47**	**-3808.47**
	runtime(s)	2.08	2.99	**0.79**	6.61	1.71
energy_house_frame3frame92	UB	**-3769.27**	**-3769.27**	**-3769.27**	**-3769.27**	**-3769.27**
	LB	**-3769.27**	**-3769.27**	**-3769.27**	**-3769.27**	**-3769.27**
	runtime(s)	3.05	3.64	**1.12**	11.88	1.87
energy_house_frame3frame93	UB	**-3763.96**	**-3763.96**	**-3763.96**	**-3763.96**	**-3763.96**
	LB	**-3763.96**	**-3763.96**	**-3763.96**	**-3763.96**	**-3763.96**
	runtime(s)	3.38	3.63	**1.56**	12.86	3.31
energy_house_frame4frame89	UB	**-3826.43**	**-3826.43**	**-3826.43**	**-3826.43**	**-3826.43**
	LB	**-3826.43**	**-3826.43**	**-3826.43**	**-3826.43**	**-3826.43**
	runtime(s)	2.08	2.36	**1.00**	9.00	2.12
energy_house_frame4frame90	UB	**-3772.11**	**-3772.11**	**-3772.11**	**-3772.11**	**-3772.11**
	LB	**-3772.11**	**-3772.11**	**-3772.11**	**-3772.11**	**-3772.11**
	runtime(s)	2.08	2.36	**1.55**	12.91	2.29
energy_house_frame4frame91	UB	**-3813.78**	**-3813.78**	**-3813.78**	**-3813.78**	**-3813.78**
	LB	**-3813.78**	**-3813.78**	**-3813.78**	**-3813.78**	**-3813.78**
	runtime(s)	2.08	2.68	**1.00**	8.87	2.99
energy_house_frame4frame92	UB	**-3769.21**	**-3769.21**	**-3769.21**	**-3769.21**	**-3769.21**
	LB	**-3769.21**	**-3769.21**	**-3769.21**	**-3769.21**	**-3769.21**
	runtime(s)	2.73	3.95	**1.88**	12.89	3.15
energy_house_frame4frame93	UB	**-3770.02**	**-3770.02**	**-3770.02**	**-3770.02**	**-3770.02**
	LB	**-3770.02**	**-3770.02**	**-3770.02**	**-3770.02**	**-3770.02**
	runtime(s)	3.05	3.63	2.21	12.91	**1.78**
energy_house_frame4frame94	UB	**-3781.42**	**-3781.42**	**-3781.42**	**-3781.42**	**-3781.42**
	LB	**-3781.42**	**-3781.42**	**-3781.42**	**-3781.42**	**-3781.42**
	runtime(s)	2.41	3.33	**1.66**	12.92	2.72

Table 6: Per-instance results. UB means primal solution energy, LB dual lower bound and runtime(s) the runtime of the particular algorithm in seconds. **Bold numbers** indicate lowest primal energy, highest lower bound and smallest runtime.

Instance		AMP	AMCF	GM	HBP	DD
energy_house_frame5frame90	UB	**-3757.48**	**-3757.48**	**-3757.48**	**-3757.48**	**-3757.48**
	LB	**-3757.48**	**-3757.48**	**-3757.48**	**-3757.48**	**-3757.48**
	runtime(s)	2.40	2.04	**1.44**	37.31	1.94
energy_house_frame5frame91	UB	**-3801.56**	**-3801.56**	**-3801.56**	**-3801.56**	**-3801.56**
	LB	**-3801.56**	**-3801.56**	**-3801.56**	**-3801.56**	**-3801.56**
	runtime(s)	2.09	2.36	**0.90**	8.11	1.78
energy_house_frame5frame92	UB	**-3759.36**	**-3759.36**	**-3759.36**	**-3759.36**	**-3759.36**
	LB	**-3759.36**	**-3759.36**	**-3759.36**	**-3759.36**	**-3759.36**
	runtime(s)	2.74	2.68	**1.34**	18.41	2.52
energy_house_frame5frame93	UB	**-3764.02**	**-3764.02**	**-3764.02**	**-3764.02**	**-3764.02**
	LB	**-3764.02**	**-3764.02**	**-3764.02**	**-3764.02**	**-3764.02**
	runtime(s)	3.05	3.00	**1.66**	12.93	2.15
energy_house_frame5frame94	UB	**-3765.23**	**-3765.23**	**-3765.23**	**-3765.23**	**-3765.23**
	LB	**-3765.23**	**-3765.23**	**-3765.23**	**-3765.23**	**-3765.23**
	runtime(s)	2.73	2.68	**1.56**	12.87	2.06
energy_house_frame5frame95	UB	**-3773.62**	**-3773.62**	**-3773.62**	**-3773.62**	**-3773.62**
	LB	**-3773.62**	**-3773.62**	**-3773.62**	**-3773.62**	**-3773.62**
	runtime(s)	3.37	3.01	**1.55**	11.99	1.72
energy_house_frame6frame91	UB	**-3824.94**	**-3824.94**	**-3824.94**	**-3824.94**	**-3824.94**
	LB	**-3824.94**	**-3824.94**	**-3824.94**	**-3824.94**	**-3824.94**
	runtime(s)	1.77	2.36	**1.11**	7.96	2.60
energy_house_frame6frame92	UB	**-3779.95**	**-3779.95**	**-3779.95**	**-3779.95**	**-3779.95**
	LB	**-3779.95**	**-3779.95**	**-3779.95**	**-3779.95**	**-3779.95**
	runtime(s)	3.05	3.32	**1.56**	12.95	2.34
energy_house_frame6frame93	UB	**-3780.40**	**-3780.40**	**-3780.40**	**-3780.40**	**-3780.40**
	LB	**-3780.40**	**-3780.40**	**-3780.40**	**-3780.40**	**-3780.40**
	runtime(s)	3.69	3.00	**2.32**	16.16	3.18
energy_house_frame6frame94	UB	**-3787.27**	**-3787.27**	**-3787.27**	**-3787.27**	**-3787.27**
	LB	**-3787.27**	**-3787.27**	**-3787.27**	**-3787.27**	**-3787.27**
	runtime(s)	2.09	2.78	**1.77**	17.81	2.27
energy_house_frame6frame95	UB	**-3794.15**	**-3794.15**	**-3794.15**	**-3794.15**	**-3794.15**
	LB	**-3794.15**	**-3794.15**	**-3794.15**	**-3794.15**	**-3794.15**
	runtime(s)	3.37	3.31	**1.78**	11.84	2.06
energy_house_frame6frame96	UB	**-3770.58**	**-3770.58**	**-3770.58**	**-3770.58**	**-3770.58**
	LB	**-3770.58**	**-3770.58**	**-3770.58**	**-3770.58**	**-3770.58**
	runtime(s)	3.70	3.00	**2.03**	28.82	2.20
energy_house_frame7frame92	UB	**-3764.47**	**-3764.47**	**-3764.47**	**-3764.47**	**-3764.47**
	LB	**-3764.47**	**-3764.47**	**-3764.47**	**-3764.47**	**-3764.47**
	runtime(s)	3.05	3.31	**1.66**	16.11	3.04
energy_house_frame7frame93	UB	**-3768.98**	**-3768.98**	**-3768.98**	**-3768.98**	**-3768.98**
	LB	**-3768.98**	**-3768.98**	**-3768.98**	**-3768.98**	**-3768.98**
	runtime(s)	3.38	3.63	**2.09**	28.11	2.29
energy_house_frame7frame94	UB	**-3771.82**	**-3771.82**	**-3771.82**	**-3771.82**	**-3771.82**
	LB	**-3771.82**	**-3771.82**	**-3771.82**	**-3771.82**	**-3771.82**
	runtime(s)	2.41	3.08	**1.66**	12.86	2.32
energy_house_frame7frame95	UB	**-3780.66**	**-3780.66**	**-3780.66**	**-3780.66**	**-3780.66**
	LB	**-3780.66**	**-3780.66**	**-3780.66**	**-3780.66**	**-3780.66**
	runtime(s)	3.38	3.19	**1.67**	16.48	2.16
energy_house_frame7frame96	UB	**-3755.85**	**-3755.85**	**-3755.85**	**-3755.85**	**-3755.85**
	LB	**-3755.85**	**-3755.85**	**-3755.85**	**-3755.85**	**-3755.85**
	runtime(s)	4.03	3.00	**1.99**	17.88	2.67
energy_house_frame7frame97	UB	**-3712.31**	**-3712.31**	**-3712.31**	**-3712.31**	**-3712.31**
	LB	**-3712.31**	**-3712.31**	**-3712.31**	**-3712.31**	**-3712.31**
	runtime(s)	3.37	3.63	**2.54**	17.82	4.17
energy_house_frame8frame93	UB	**-3787.12**	**-3787.12**	**-3787.12**	**-3787.12**	**-3787.12**
	LB	**-3787.12**	**-3787.12**	**-3787.12**	**-3787.12**	**-3787.12**
	runtime(s)	3.38	3.96	**2.32**	21.87	2.78
energy_house_frame8frame94	UB	**-3794.54**	**-3794.54**	**-3794.54**	**-3794.54**	**-3794.54**
	LB	**-3794.54**	**-3794.54**	**-3794.54**	**-3794.54**	**-3794.54**
	runtime(s)	3.05	3.96	2.32	16.17	**2.13**

Table 6: Per-instance results. UB means primal solution energy, LB dual lower bound and runtime(s) the runtime of the particular algorithm in seconds. **Bold numbers** indicate lowest primal energy, highest lower bound and smallest runtime.

Instance		AMP	AMCF	GM	HBP	DD
energy_house_frame8frame95	UB	**-3800.01**	**-3800.01**	**-3800.01**	**-3800.01**	**-3800.01**
	LB	**-3800.01**	**-3800.01**	**-3800.01**	**-3800.01**	**-3800.01**
	runtime(s)	4.02	4.58	2.54	28.82	**2.29**
energy_house_frame8frame96	UB	**-3781.83**	**-3781.83**	**-3781.83**	**-3781.83**	**-3781.83**
	LB	**-3781.83**	**-3781.83**	**-3781.83**	**-3781.83**	**-3781.83**
	runtime(s)	4.67	5.22	3.51	16.45	**3.14**
energy_house_frame8frame97	UB	**-3738.27**	**-3738.27**	**-3738.27**	**-3738.27**	**-3738.27**
	LB	**-3738.27**	**-3738.27**	**-3738.27**	**-3738.27**	**-3738.27**
	runtime(s)	4.35	5.24	6.04	16.24	**2.53**
energy_house_frame8frame98	UB	**-3759.21**	**-3759.21**	**-3759.21**	**-3759.21**	**-3759.21**
	LB	**-3759.21**	**-3759.21**	**-3759.21**	**-3759.21**	**-3759.21**
	runtime(s)	4.99	6.17	2.64	21.78	**2.29**
energy_house_frame9frame94	UB	**-3806.80**	**-3806.80**	**-3806.80**	**-3806.80**	**-3806.80**
	LB	**-3806.80**	**-3806.80**	**-3806.80**	**-3806.80**	**-3806.80**
	runtime(s)	1.76	2.38	**0.90**	8.27	2.47
energy_house_frame9frame95	UB	**-3811.22**	**-3811.22**	**-3811.22**	**-3811.22**	**-3811.22**
	LB	**-3811.22**	**-3811.22**	**-3811.22**	**-3811.22**	**-3811.22**
	runtime(s)	2.09	2.70	**1.01**	9.27	2.05
energy_house_frame9frame96	UB	**-3797.97**	**-3797.97**	**-3797.97**	**-3797.97**	**-3797.97**
	LB	**-3797.97**	**-3797.97**	**-3797.97**	**-3797.97**	**-3797.97**
	runtime(s)	2.08	2.36	**1.01**	9.29	2.55
energy_house_frame9frame97	UB	**-3748.62**	**-3748.62**	**-3748.62**	**-3748.62**	**-3748.62**
	LB	**-3748.62**	**-3748.62**	**-3748.62**	**-3748.62**	**-3748.62**
	runtime(s)	2.09	3.00	**1.12**	16.17	2.98
energy_house_frame9frame98	UB	**-3770.40**	**-3770.40**	**-3770.40**	**-3770.40**	**-3770.40**
	LB	**-3770.40**	**-3770.40**	**-3770.40**	**-3770.40**	**-3770.40**
	runtime(s)	2.40	3.63	**0.90**	9.01	2.53
energy_house_frame9frame99	UB	**-3726.83**	**-3726.83**	**-3726.83**	**-3726.83**	**-3726.83**
	LB	**-3726.83**	**-3726.83**	**-3726.83**	**-3726.83**	**-3726.83**
	runtime(s)	3.05	3.63	**1.55**	18.35	2.66
	Hassan					
board_torresani	UB	**-2262.66**	**-2262.66**	**-2262.66**	-2236.29	**-2262.66**
	LB	**-2262.66**	**-2262.66**	**-2262.66**	-2263.27	**-2262.66**
	runtime(s)	2.58	**2.57**	3.24	54.25	3.23
books_torresani	UB	-4124.40	-4105.15	-4091.01	-2991.97	**-4135.27**
	LB	-4153.99	-4163.54	-4200.55	-4232.44	**-4137.02**
	runtime(s)	459.31	480.94	464.50	444.69	**45.79**
hammer_torresani	UB	**-2097.78**	-2092.19	-1901.89	-903.62	**-2097.78**
	LB	-2108.19	-2119.02	-2138.38	-2169.68	**-2097.78**
	runtime(s)	305.12	312.79	302.55	218.99	**17.60**
party_torresani	UB	**-3629.91**	**-3629.91**	**-3629.91**	-3005.44	**-3629.91**
	LB	-3643.57	-3639.94	-3662.25	-3671.11	**-3629.91**
	runtime(s)	292.56	334.90	258.55	220.28	**16.76**
table_torresani	UB	-3278.81	-3261.48	-3277.33	-2328.58	**-3288.51**
	LB	-3305.51	-3312.67	-3301.49	-3369.81	**-3288.51**
	runtime(s)	245.39	249.47	255.71	151.99	**7.68**
walking_torresani	UB	**-1625.85**	-1625.55	**-1625.85**	**-1625.85**	**-1625.85**
	LB	**-1625.85**	**-1625.85**	**-1625.85**	-1627.00	**-1625.85**
	runtime(s)	**4.35**	8.53	13.78	76.41	16.47
	car					
car1	UB	**-34.88**	**-34.88**	**-34.88**	**-34.88**	**-34.88**
	LB	**-34.88**	**-34.88**	**-34.88**	**-34.88**	**-34.88**
	runtime(s)	**1.48**	1.94	20.52	5.13	8.56
car10	UB	**-57.62**	**-57.62**	**-57.62**	**-57.62**	-46.19
	LB	**-57.62**	**-57.62**	**-57.62**	**-57.62**	-58.66
	runtime(s)	**5.38**	11.43	13.41	17.78	60.73
car11	UB	**-63.06**	**-63.06**	**-63.06**	**-63.06**	**-63.06**
	LB	**-63.06**	**-63.06**	**-63.06**	**-63.06**	**-63.06**
	runtime(s)	**2.20**	5.58	4.19	13.39	18.39

Table 6: Per-instance results. UB means primal solution energy, LB dual lower bound and runtime(s) the runtime of the particular algorithm in seconds. **Bold numbers** indicate lowest primal energy, highest lower bound and smallest runtime.

Instance		AMP	AMCF	GM	HBP	DD
car12	UB	**-57.36**	-55.88	**-57.36**	**-57.36**	-37.26
	LB	**-57.36**	**-57.36**	**-57.36**	**-57.36**	-59.47
	runtime(s)	**4.92**	8.87	36.30	25.84	55.86
car13	UB	**-72.15**	**-72.15**	**-72.15**	**-72.15**	-58.93
	LB	**-72.15**	**-72.15**	**-72.15**	**-72.15**	-73.94
	runtime(s)	15.10	**8.94**	22.94	49.63	54.78
car14	UB	**-97.96**	-97.70	-97.52	-97.77	-60.72
	LB	-98.15	**-98.02**	-98.32	-98.77	-120.95
	runtime(s)	3614.22	3615.70	3610.92	2833.06	**114.21**
car15	UB	**-66.89**	**-66.89**	**-66.89**	**-66.89**	**-66.89**
	LB	**-66.89**	**-66.89**	**-66.89**	**-66.89**	-67.17
	runtime(s)	**2.61**	6.55	13.85	35.16	37.40
car16	UB	**-68.21**	**-68.21**	**-68.21**	**-68.21**	**-68.21**
	LB	**-68.21**	**-68.21**	**-68.21**	**-68.21**	**-68.21**
	runtime(s)	6.25	**5.13**	13.07	34.80	55.55
car17	UB	**-57.09**	**-57.09**	**-57.09**	**-57.09**	**-57.09**
	LB	**-57.09**	**-57.09**	**-57.09**	**-57.09**	-57.09
	runtime(s)	**4.78**	12.26	94.38	10.31	76.36
car18	UB	**-92.18**	**-92.18**	**-92.18**	**-92.18**	**-92.18**
	LB	**-92.18**	**-92.18**	**-92.18**	**-92.18**	**-92.18**
	runtime(s)	**15.08**	18.47	29.70	114.35	105.84
car19	UB	**-115.11**	**-115.11**	**-115.11**	**-115.11**	-80.58
	LB	**-115.11**	**-115.11**	**-115.11**	**-115.11**	-120.55
	runtime(s)	**82.44**	109.77	132.66	1604.25	349.92
car2	UB	**-48.85**	**-48.85**	**-48.85**	**-48.85**	**-48.85**
	LB	**-48.85**	**-48.85**	**-48.85**	-48.85	**-48.85**
	runtime(s)	93.72	138.94	215.20	67.66	**32.59**
car20	UB	**-106.69**	**-106.69**	**-106.69**	**-106.69**	-94.48
	LB	**-106.69**	**-106.69**	**-106.69**	**-106.69**	-107.46
	runtime(s)	20.42	20.15	**17.38**	56.33	163.27
car21	UB	**-94.55**	**-94.55**	**-94.55**	**-94.55**	**-94.55**
	LB	**-94.55**	**-94.55**	**-94.55**	**-94.55**	**-94.55**
	runtime(s)	63.10	**57.48**	86.08	302.83	145.09
car22	UB	**-55.58**	**-55.58**	**-55.58**	**-55.58**	**-55.58**
	LB	**-55.58**	**-55.58**	**-55.58**	**-55.58**	**-55.58**
	runtime(s)	1.69	**1.47**	1.72	3.43	27.37
car23	UB	**-70.20**	-64.70	**-70.20**	**-70.20**	-47.36
	LB	**-70.20**	**-70.20**	**-70.20**	**-70.20**	-75.29
	runtime(s)	**29.92**	61.96	41.27	165.15	63.77
car24	UB	**-64.58**	**-64.58**	**-64.58**	**-64.58**	-55.40
	LB	**-64.58**	**-64.58**	**-64.58**	**-64.58**	-66.32
	runtime(s)	146.68	139.16	392.19	1158.90	**48.65**
car25	UB	**-34.19**	**-34.19**	**-34.19**	**-34.19**	**-34.19**
	LB	**-34.19**	**-34.19**	**-34.19**	**-34.19**	**-34.19**
	runtime(s)	**2.01**	4.20	16.96	8.67	17.74
car26	UB	**-59.92**	-56.97	**-59.92**	**-59.92**	**-59.92**
	LB	**-59.92**	**-59.92**	**-59.92**	**-59.92**	-59.98
	runtime(s)	27.64	**17.56**	53.86	63.54	56.01
car27	UB	**-67.95**	**-67.95**	**-67.95**	**-67.95**	**-67.95**
	LB	**-67.95**	**-67.95**	**-67.95**	**-67.95**	**-67.95**
	runtime(s)	**13.41**	25.23	28.80	81.25	54.91
car28	UB	**-74.92**	-74.15	-71.70	-74.73	-38.23
	LB	-77.06	**-76.90**	-77.96	-78.18	-113.45
	runtime(s)	3630.63	3629.86	3621.74	2392.52	**133.85**
car29	UB	**-84.31**	-81.76	**-84.31**	**-84.31**	-48.33
	LB	**-84.37**	-84.40	-84.78	-84.73	-93.55
	runtime(s)	3300.78	3255.77	2735.09	2103.61	**111.87**
car3	UB	**-86.55**	**-86.55**	**-86.55**	**-86.55**	-54.10
	LB	**-86.55**	**-86.55**	-86.61	-86.64	-99.20
	runtime(s)	1231.46	340.40	3612.01	2044.42	**158.59**

Table 6: Per-instance results. UB means primal solution energy, LB dual lower bound and runtime(s) the runtime of the particular algorithm in seconds. **Bold numbers** indicate lowest primal energy, highest lower bound and smallest runtime.

Instance		AMP	AMCF	GM	HBP	DD
car30	UB	**-58.85**	**-58.85**	**-58.85**	**-58.85**	-52.63
	LB	**-58.85**	**-58.85**	**-58.85**	**-58.85**	-60.48
	runtime(s)	41.33	87.70	207.34	62.66	**40.45**
car4	UB	**-51.17**	-49.20	-49.38	-50.64	-33.85
	LB	**-54.00**	-54.36	-55.65	-55.69	-61.03
	runtime(s)	1539.03	1791.20	1689.60	720.89	**77.74**
car5	UB	-65.24	-63.51	-49.11	**-66.25**	-36.53
	LB	-68.15	**-67.82**	-69.00	-69.93	-83.96
	runtime(s)	2971.41	3614.74	3611.02	1389.58	**121.17**
car6	UB	**-83.78**	-83.10	-82.53	-82.52	-49.51
	LB	**-83.88**	-84.07	-84.14	-84.09	-90.13
	runtime(s)	2495.72	3477.40	2434.92	1403.09	**238.56**
car7	UB	**-81.95**	**-81.95**	**-81.95**	**-81.95**	**-81.95**
	LB	**-81.95**	**-81.95**	**-81.95**	**-81.95**	**-81.95**
	runtime(s)	14.95	**13.28**	14.09	46.10	43.76
car8	UB	-43.95	-41.22	-38.30	**-44.00**	-31.55
	LB	**-44.42**	-44.64	-46.72	-44.70	-52.72
	runtime(s)	326.15	480.89	526.10	356.44	**28.05**
car9	UB	**-62.40**	**-62.40**	**-62.40**	**-62.40**	**-62.40**
	LB	**-62.40**	**-62.40**	**-62.40**	**-62.40**	**-62.40**
	runtime(s)	1.37	**0.22**	0.26	1.55	10.20
	motor					
motor1	UB	**-94.18**	**-94.18**	**-94.18**	**-94.18**	-46.36
	LB	**-94.18**	**-94.18**	-94.20	-94.23	-115.29
	runtime(s)	576.63	915.02	3625.61	3181.60	**168.71**
motor10	UB	**-48.95**	**-48.95**	-48.05	**-48.95**	**-48.95**
	LB	**-48.95**	**-48.95**	**-48.95**	**-48.95**	**-48.95**
	runtime(s)	0.98	**0.87**	3.68	7.00	10.45
motor11	UB	**-50.16**	**-50.16**	**-50.16**	**-50.16**	**-50.16**
	LB	**-50.16**	**-50.16**	**-50.16**	**-50.16**	**-50.16**
	runtime(s)	**0.27**	0.87	2.33	2.51	15.45
motor12	UB	**-55.81**	**-55.81**	**-55.81**	**-55.81**	**-55.81**
	LB	**-55.81**	**-55.81**	**-55.81**	**-55.81**	**-55.81**
	runtime(s)	**5.08**	5.65	14.42	21.04	22.16
motor13	UB	**-36.35**	**-36.35**	**-36.35**	**-36.35**	**-36.35**
	LB	-36.36	**-36.35**	-36.37	**-36.35**	**-36.35**
	runtime(s)	36.13	**7.80**	189.60	29.00	18.18
motor14	UB	**-43.80**	-41.49	-39.95	-43.47	-42.99
	LB	-44.35	-44.50	-45.21	**-44.25**	-44.77
	runtime(s)	492.28	453.56	670.01	393.21	**57.10**
motor15	UB	**-32.30**	**-32.30**	**-32.30**	**-32.30**	-27.19
	LB	**-32.30**	**-32.30**	-32.33	-32.30	-33.74
	runtime(s)	**8.53**	9.91	82.75	53.03	13.99
motor16	UB	**-75.13**	**-75.13**	**-75.13**	**-75.13**	**-75.13**
	LB	**-75.13**	**-75.13**	**-75.13**	**-75.13**	**-75.13**
	runtime(s)	33.22	19.71	**19.04**	114.67	123.36
motor17	UB	**-84.38**	**-84.38**	**-84.38**	**-84.38**	-83.99
	LB	**-84.38**	**-84.38**	**-84.38**	-84.41	-85.24
	runtime(s)	**67.35**	431.98	740.71	463.66	149.62
motor18	UB	**-131.41**	**-131.41**	**-131.41**	**-131.41**	-120.90
	LB	**-131.41**	**-131.41**	**-131.41**	**-131.41**	-131.86
	runtime(s)	63.01	46.24	**44.81**	424.98	365.89
motor19	UB	**-75.29**	**-75.29**	**-75.29**	**-75.29**	**-75.29**
	LB	**-75.29**	**-75.29**	**-75.29**	**-75.29**	**-75.29**
	runtime(s)	1.02	**0.52**	3.37	15.85	26.00
motor2	UB	**-94.93**	**-94.93**	**-94.93**	**-94.93**	**-94.93**
	LB	**-94.93**	**-94.93**	**-94.93**	**-94.93**	**-94.93**
	runtime(s)	9.53	1.00	**0.92**	32.43	57.88
motor20	UB	**-82.10**	**-82.10**	**-82.10**	**-82.10**	-79.77
	LB	**-82.10**	**-82.10**	**-82.10**	-82.18	-83.24
	runtime(s)	49.05	**43.97**	142.10	1155.51	145.62

Table 6: Per-instance results. UB means primal solution energy, LB dual lower bound and runtime(s) the runtime of the particular algorithm in seconds. **Bold numbers** indicate lowest primal energy, highest lower bound and smallest runtime.

Instance		AMP	AMCF	GM	HBP	DD
motor3	UB	**-45.37**	**-45.37**	**-45.37**	**-45.37**	**-45.37**
	LB	**-45.37**	**-45.37**	**-45.37**	**-45.37**	**-45.37**
	runtime(s)	**1.12**	2.59	19.42	5.99	9.11
motor4	UB	**-27.50**	**-27.50**	**-27.50**	**-27.50**	**-27.50**
	LB	**-27.50**	**-27.50**	**-27.50**	**-27.50**	**-27.50**
	runtime(s)	0.14	**0.10**	0.68	0.35	1.47
motor5	UB	**-29.91**	**-29.91**	**-29.91**	**-29.91**	**-29.91**
	LB	**-29.91**	**-29.91**	**-29.91**	**-29.91**	**-29.91**
	runtime(s)	0.04	**0.02**	0.12	0.12	1.05
motor6	UB	**-51.51**	**-51.51**	**-51.51**	**-51.51**	**-51.51**
	LB	**-51.51**	**-51.51**	**-51.51**	**-51.51**	**-51.51**
	runtime(s)	**1.07**	1.10	4.97	4.67	10.25
motor7	UB	**-64.93**	**-64.93**	**-64.93**	**-64.93**	**-64.93**
	LB	**-64.93**	**-64.93**	**-64.93**	**-64.93**	**-64.93**
	runtime(s)	6.37	**3.32**	21.00	21.14	52.96
motor8	UB	**-79.71**	**-79.71**	**-79.71**	**-79.71**	**-79.71**
	LB	**-79.71**	**-79.71**	**-79.71**	**-79.71**	-79.87
	runtime(s)	62.98	**23.81**	104.01	416.33	123.32
motor9	UB	**-55.17**	**-55.17**	**-55.17**	**-55.17**	**-55.17**
	LB	**-55.17**	**-55.17**	**-55.17**	**-55.17**	**-55.17**
	runtime(s)	**1.57**	3.31	14.15	9.02	11.89
	worms					
C18G1_2L1_1-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-46310.40**	-46070.09	inf	-45774.10	3396.88
	LB	**-46310.87**	-46339.35	-46366.44	-46334.22	-60642.07
	runtime(s)	207.40	593.32	**194.37**	289.49	1482.13
cnd1threeL1_1213061-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-49998.17**	-49933.02	inf	-49979.79	-17409.57
	LB	**-49998.17**	-50000.88	-50003.44	-50002.52	-61715.51
	runtime(s)	**14.33**	570.65	22.99	204.90	1520.45
cnd1threeL1_1228061-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-50553.88**	-50499.12	inf	-50528.66	-4741.50
	LB	**-50553.88**	-50555.70	-50576.63	-50567.57	-73855.69
	runtime(s)	69.22	771.24	**59.42**	404.33	1498.98
cnd1threeL1_1229061-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-49113.04**	-49042.26	inf	-49024.03	-15101.58
	LB	**-49119.90**	-49133.09	-49177.09	-49143.20	-56976.00
	runtime(s)	208.76	484.13	**66.55**	207.18	1424.92
cnd1threeL1_1229062-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-49414.48**	-49217.71	inf	-49159.46	-7233.37
	LB	**-49427.52**	-49446.99	-49452.32	-49441.35	-65090.03
	runtime(s)	249.81	615.87	**141.67**	280.93	1438.74
cnd1threeL1_1229063-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-50480.36**	-50425.15	inf	-50427.31	-11408.78
	LB	**-50480.36**	-50492.21	-50499.47	-50489.68	-63543.89
	runtime(s)	133.26	637.62	**39.45**	296.92	1525.52
eft3RW10035L1_0125071-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-47038.08**	-46898.52	inf	-46643.35	6389.96
	LB	**-47075.02**	-47113.47	-47120.22	-47110.52	-66393.07
	runtime(s)	**264.14**	374.47	614.80	361.89	1439.53
eft3RW10035L1_0125072-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-49243.13**	-49128.56	inf	-49156.19	-10301.00
	LB	**-49273.44**	-49291.64	-49373.97	-49305.48	-61184.07
	runtime(s)	378.21	627.18	**53.24**	330.01	1415.11
eft3RW10035L1_0125073-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-45145.48**	-44994.08	inf	-44960.05	4993.09
	LB	**-45152.87**	-45186.69	-45262.48	-45189.34	-55876.38
	runtime(s)	191.76	491.98	**133.49**	266.09	1391.44
egl5L1_0606074-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-42290.34**	-41752.20	inf	-41510.29	25094.04
	LB	**-42438.31**	-42527.52	-42557.47	-42522.95	-62140.57
	runtime(s)	**296.69**	436.30	393.89	344.93	1447.15
elt3L1_0503071-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-48663.64**	-48597.23	inf	-48553.52	-12597.30
	LB	**-48665.33**	-48682.63	-48685.64	-48683.32	-61435.00
	runtime(s)	286.57	514.79	**165.60**	298.29	1546.62
elt3L1_0503072-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-50403.27**	-50323.34	inf	-50204.28	-17439.71
	LB	**-50404.54**	-50419.53	-50430.55	-50433.43	-64443.67
	runtime(s)	308.49	564.10	**130.73**	384.55	1542.32
elt3L1_0504073-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-45831.06**	-45567.68	inf	-45728.81	8747.71
	LB	**-45831.06**	-45847.62	-45895.93	-45868.27	-63468.72
	runtime(s)	90.98	592.91	**50.99**	217.13	1392.60

Table 6: Per-instance results. UB means primal solution energy, LB dual lower bound and runtime(s) the runtime of the particular algorithm in seconds. **Bold numbers** indicate lowest primal energy, highest lower bound and smallest runtime.

Instance		AMP	AMCF	GM	HBP	DD
hlh1fourL1_0417071-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-46836.83**	-46533.33	inf	-46408.66	854.23
	LB	**-47032.22**	-47086.83	-47119.47	-47082.80	-63780.52
	runtime(s)	**262.59**	543.30	483.25	313.96	1439.73
hlh1fourL1_0417075-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-49550.13**	-49409.57	inf	-49530.58	-12058.87
	LB	**-49550.13**	-49566.47	-49641.38	-49558.24	-61647.72
	runtime(s)	**18.79**	789.50	73.30	382.49	1511.04
hlh1fourL1_0417076-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-48403.69**	-48315.54	inf	-48321.19	-53.31
	LB	**-48404.77**	-48414.68	-48434.31	-48420.78	-63809.37
	runtime(s)	334.20	737.72	342.43	**286.27**	1471.41
hlh1fourL1_0417077-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-48071.87**	-47907.39	inf	-48024.64	-1259.67
	LB	**-48071.87**	-48093.76	-48107.28	-48097.67	-63985.70
	runtime(s)	**97.92**	789.72	182.47	259.06	1500.05
hlh1fourL1_0417078-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-48236.10**	-48133.31	inf	-48130.23	-10622.12
	LB	**-48236.37**	-48242.47	-48250.18	-48254.45	-61492.56
	runtime(s)	599.12	745.14	800.89	**263.29**	1445.43
mir61L1_1228061-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-48777.03**	-48637.86	inf	-48677.84	-5805.11
	LB	**-48788.87**	-48800.51	-48842.39	-48807.78	-60780.51
	runtime(s)	319.10	542.99	302.49	**280.86**	1452.32
mir61L1_1228062-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-49415.47**	-49315.92	inf	-49332.57	-14934.02
	LB	**-49419.06**	-49423.49	-49447.95	-49431.13	-59976.84
	runtime(s)	358.76	638.51	716.44	**289.63**	1482.86
mir61L1_1229062-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-49836.77**	-49696.20	inf	-49717.00	-11816.15
	LB	**-49836.77**	-49851.68	-49860.50	-49859.68	-64448.89
	runtime(s)	**277.70**	703.77	397.94	283.92	1493.55
pha4A7L1_1213061-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-47991.95**	-47816.55	inf	-47881.55	†
	LB	**-47996.18**	-48019.58	-48103.71	-48029.49	†
	runtime(s)	**254.40**	630.45	721.77	267.23	†
pha4A7L1_1213062-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-49985.66**	-49909.30	inf	-49952.46	†
	LB	**-49985.66**	-49994.59	-49995.43	-49991.35	†
	runtime(s)	20.54	900.00	**19.99**	335.07	†
pha4A7L1_1213064-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-49284.01**	-49161.13	inf	-49173.02	†
	LB	**-49320.70**	-49344.45	-49359.94	-49345.73	†
	runtime(s)	267.25	653.14	**38.14**	308.96	†
pha4B2L1_0125072-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-47230.88**	-47070.83	inf	-47109.54	†
	LB	**-47233.63**	-47257.22	-47272.88	-47264.07	†
	runtime(s)	158.91	295.26	**139.47**	218.78	†
pha4I2L_0408071-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-46106.84**	-45729.12	inf	-45602.49	2993.45
	LB	**-46124.34**	-46187.69	-46245.04	-46192.43	-61549.52
	runtime(s)	**244.49**	428.54	365.95	282.77	1420.16
pha4I2L_0408072-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-50062.40**	-49999.81	-50004.15	-50051.26	-8030.13
	LB	**-50062.40**	-50067.32	-50082.97	-50067.73	-64464.55
	runtime(s)	129.34	576.88	**122.65**	257.30	1454.57
pha4I2L_0408073-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-49497.10**	-49438.10	-49496.46	-49379.77	-5615.99
	LB	**-49497.10**	-49508.85	**-49497.10**	-49513.77	-69802.71
	runtime(s)	193.95	767.31	**64.83**	319.46	1548.78
unc54L1_0123071-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-50069.07**	-50008.12	inf	-50008.27	-13325.80
	LB	**-50069.17**	-50073.81	-50076.97	-50080.87	-60277.54
	runtime(s)	64.45	680.90	**16.82**	299.76	1516.94
unc54L1_0123072-lowThresh-more-hyp.surf-16-03-11-1745	UB	**-49775.89**	-49645.88	inf	-49708.63	-9321.43
	LB	**-49775.89**	-49783.56	-49785.75	-49787.69	-63516.95
	runtime(s)	115.50	746.36	**20.38**	334.56	1468.27