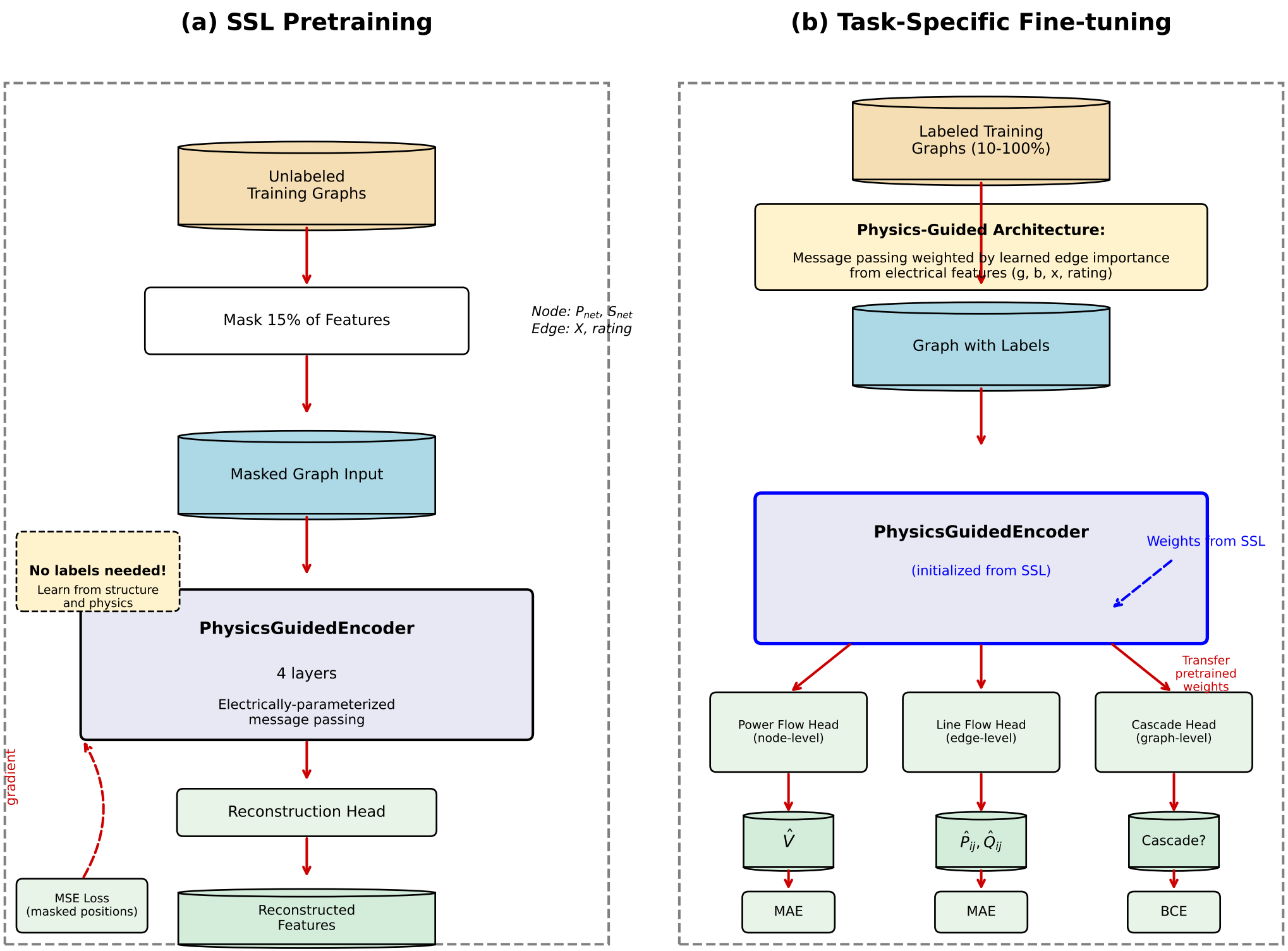
(a) SSL Pretraining
Unlabeled
Training Graphs
Mask 15% of Features
Node: P_{net}, S_{net}
Edge: X, rating
Masked Graph Input
No labels needed!
Learn from structure
and physics
PhysicsGuidedEncoder
4 layers
Electrically-parameterized
message passing
gradient
Reconstruction Head
MSE Loss
(masked positions)
Reconstructed
Features
(b) Task-Specific Fine-tuning
Labeled Training
Graphs (10-100%)
Physics-Guided Architecture:
Message passing weighted by learned edge importance
from electrical features (g, b, x, rating)
Graph with Labels
PhysicsGuidedEncoder
(initialized from SSL)
Weights from SSL
Transfer
pretrained
weights
Power Flow Head
(node-level)
Line Flow Head
(edge-level)
Cascade Head
(graph-level)
$\hat{V}$
$\hat{P}_{ij}, \hat{Q}_{ij}$
Cascade?
MAE
MAE
BCE