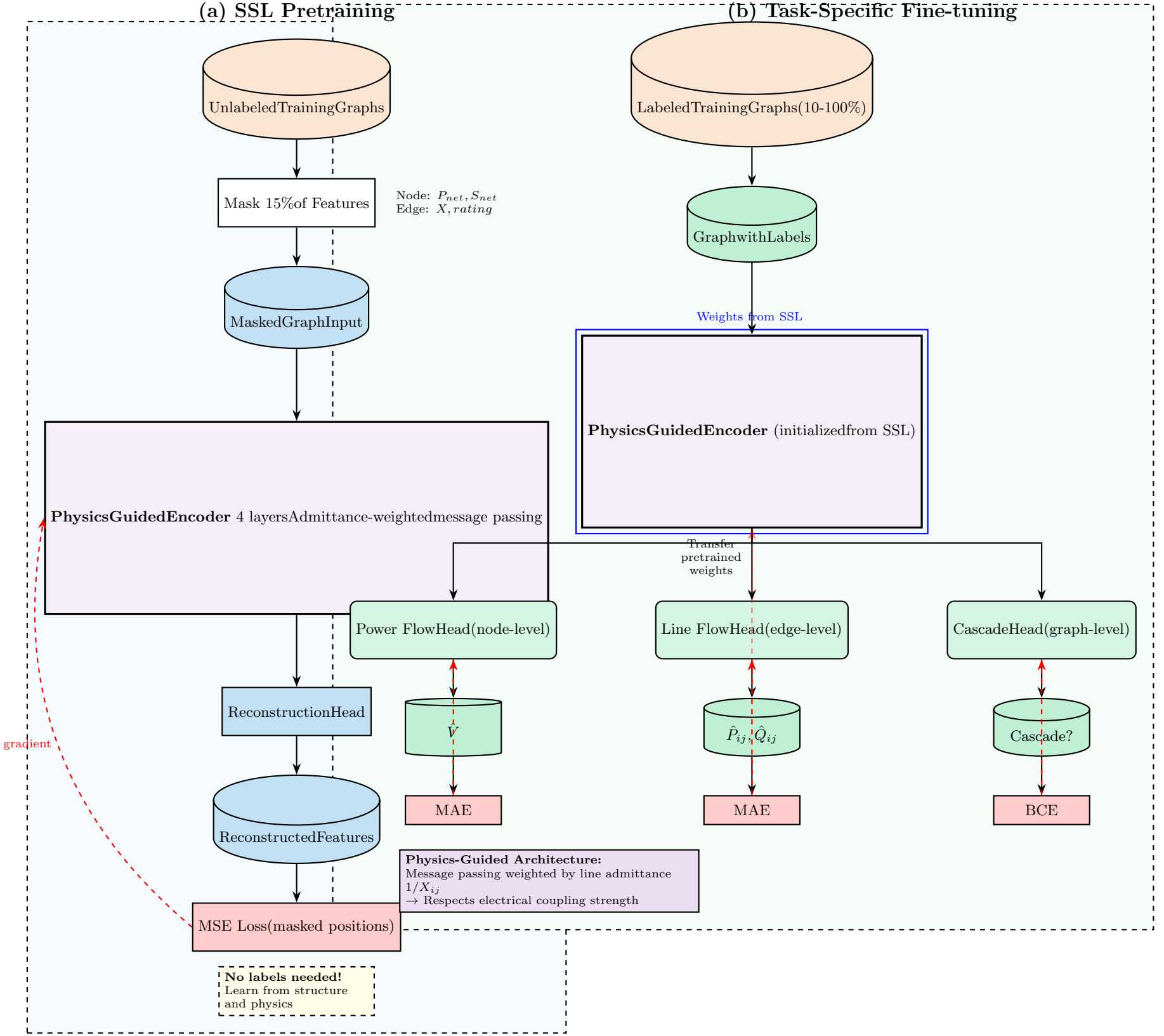
(a) SSL Pretraining
(b) Task-Specific Fine-tuning
UnlabeledTrainingGraphs
Mask 15%of Features
Node: P_{net}, S_{net}
Edge: $X, rating$
MaskedGraphInput
PhysicsGuidedEncoder 4 layersAdmittance-weightedmessage passing
ReconstructionHead
ReconstructedFeatures
MSE Loss(masked positions)
gradient
No labels needed!
Learn from structure
and physics
LabeledTrainingGraphs(10-100%)
GraphwithLabels
Weights from SSL
PhysicsGuidedEncoder (initializedfrom SSL)
Transfer
pretrained
weights
Power FlowHead(node-level)
Line FlowHead(edge-level)
CascadeHead(graph-level)
$\hat{V}$
$\hat{P}_{ij}, \hat{Q}_{ij}$
Cascade?
MAE
MAE
BCE
Physics-Guided Architecture:
Message passing weighted by line admittance $1/X_{ij}$
→ Respects electrical coupling strength