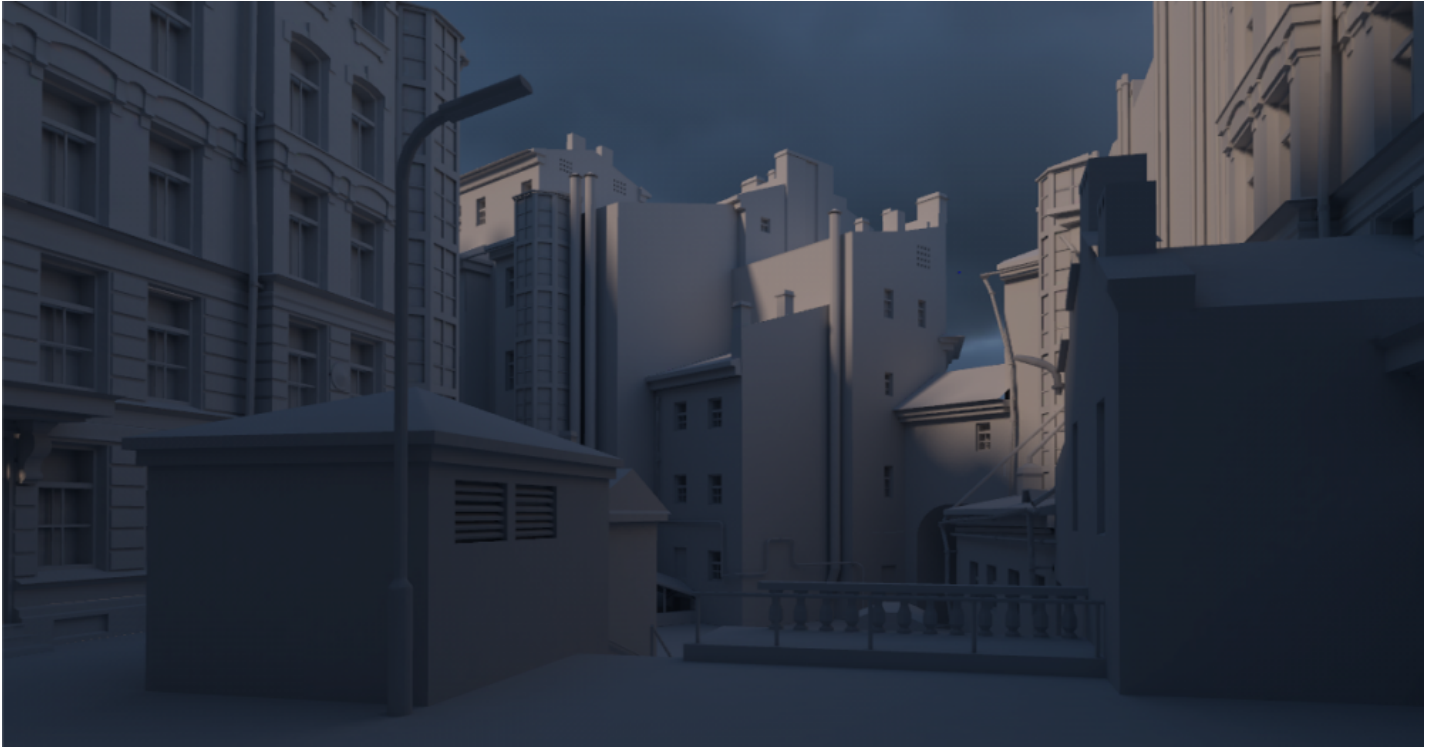


# Manual

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## System requirements

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To use Bakery you'll need:

- Windows (7 or higher) PC.
- Nvidia GPU. Minimum supported model is Kepler (GeForce 6xx or newer. For Quadro cards check the specs).
- 64-bit Unity editor. Bakery was tested on all versions from 5.6 to 2019.1.

 System requirements are for developer machine, not target platform. You can use lightmaps baked with Bakery anywhere.

## Prerequisites

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- Make sure your project does not have any script compilation errors, as it will prevent Bakery scripts from compiling as well.
- Make sure you have the latest GPU driver. [Update it \(https://www.nvidia.com/Download/index.aspx?lang=en-US\)](https://www.nvidia.com/Download/index.aspx?lang=en-US) if needed.

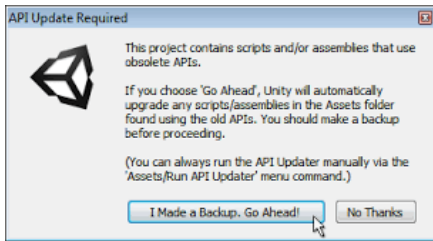
## Installation

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1. Import Bakery to your project via [Asset Store \(https://assetstore.unity.com/packages/tools/level-design/bakery-gpu-lightmapper-122218\)](https://assetstore.unity.com/packages/tools/level-design/bakery-gpu-lightmapper-122218).
2. Unity will show a list of files to import. If it's your first time using Bakery, it is recommended you just **click Import**. Experienced users may want to untick the *examples* folder for a more lightweight installation.

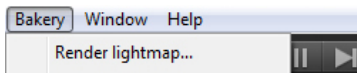
Files will be imported to Assets/Bakery and Assets/Editor/x64/Bakery. These folders can be moved later.

3. Unity will then import Bakery and compile the scripts. It may show a window like this:



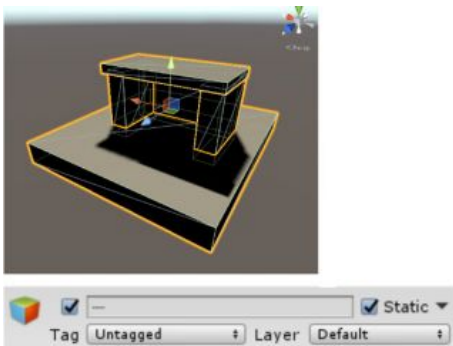
In which case you should click "Go Ahead".

You should now see Bakery menu added to the editor:




## Quickstart

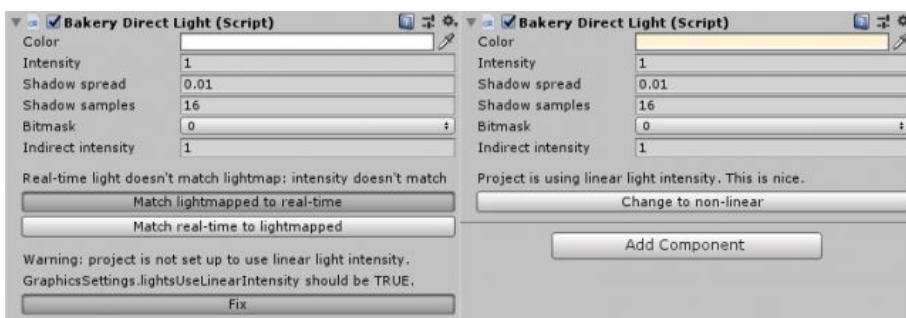
1. Add some model or primitive and mark it as Static.




2. Select Directional Light (the one Unity created for you) and add **Bakery Direct Light** component to it.

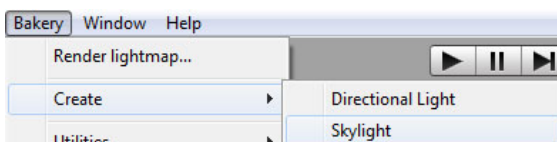
 Bakery and Unity use separate light source components.

3. Bakery Direct Light has many options to tweak, but you can easily match it to Unity light. Click **Match lightmapped to real-time**. Now Bakery light should have the same yellowish color as Unity's default Directional.



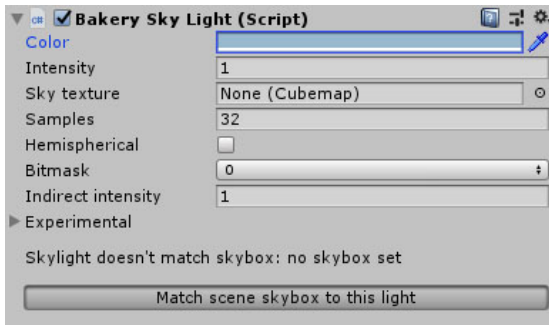
 Direct Light component may complain about project not using linear light intensity. The problem is that by default Unity applies gamma correction to light source colors incorrectly (<https://twitter.com/guycalledfrank/status/1001108508614553600>). Correct mode can be enabled by scripting (<https://docs.unity3d.com/ScriptReference/Rendering.GraphicsSettings-lightsUseLinearIntensity.html>), and that's what the "Fix" button does. If you already have many light sources set up in non-linear intensity mode, and you don't want to change them again, you may skip fixing. Even if you press "Fix", you can always revert the change anytime.

4. To get shadowed ambient lighting, create Skylight (Bakery->Create->Skylight).

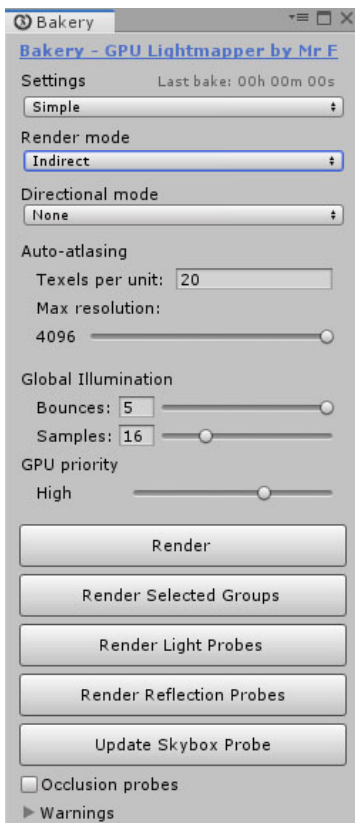


5. Select Skylight, give it some bluish color and click **Match scene skybox to this light**. This will make scene skybox match lighting exactly.

💡 Matching Unity skybox to Bakery skylight is optional but useful for correctness, as to ensure that visible environment and in-engine reflection probes match baked lighting.



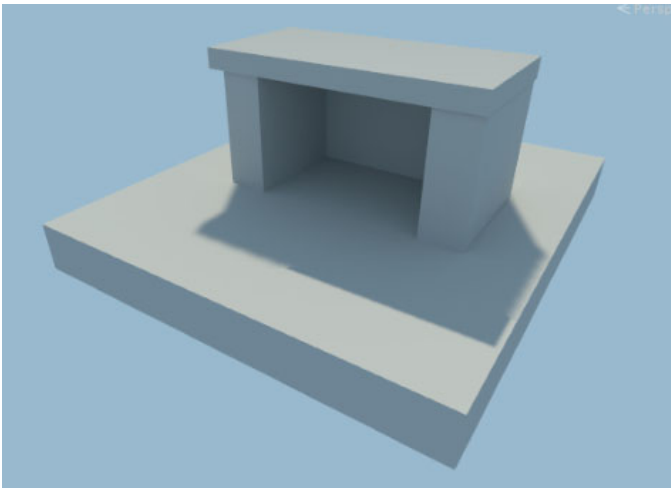
6. Click Bakery->Render Lightmap. By default, Full Lighting mode is active. It will bake both direct and indirect contribution from all lights. If you want to combine real-time shadows with baked GI, change it to **Indirect**.



💡 Bakery may complain that you are using old gamma mode (<https://docs.unity3d.com/Manual/LinearLighting.html>) and suggest to change it. If you care about quality of lighting, using Linear mode is highly recommended. You may ignore it if you already have a big project set up with incorrect gamma and don't want to change it or when shipping to mobile devices that don't support it.

7. Click **Render**.

8. Done! You should now have baked GI:



## Render settings


All render settings can be accessed via Bakery->Render Lightmap. Settings are saved for every scene. The topmost option in Bakery window allows you to switch between Simple, Advanced and Experimental settings, each succeeding mode revealing more tweakable options. Simple mode is enough for most scenes and it's a good way to get started.

### Render mode

Defines the type of lightmaps to bake.

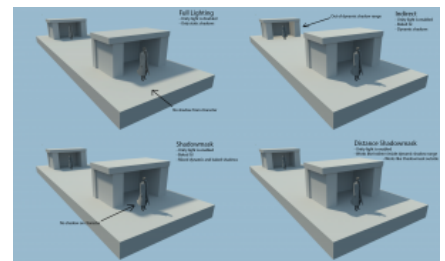
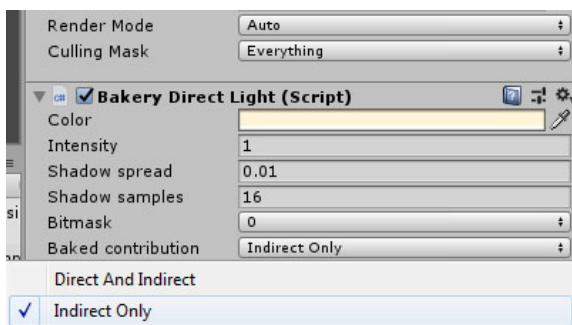
#### Full Lighting

Complete direct and indirect lighting for all Bakery lights.

 On pre-2017.3 Unity versions if you have both Unity and Bakery components on the same object, you will need to disable Unity ones manually to avoid double brightness. On newer versions real-time effects are automatically disabled for baked lights, as with built-in lightmappers.

### Indirect

Basic mixed mode. It will look at the Baked Contribution selector on every light: if it's set to *Direct And Indirect*, the light is baked as in Full Lighting mode. If it's set to *Indirect Only*, only indirect contribution (GI) from this light is baked. In latter case you should keep both Unity and Bakery lights on the object, one giving real-time direct contribution, and another for precomputed GI.



Comparison of different render modes supported by Unity

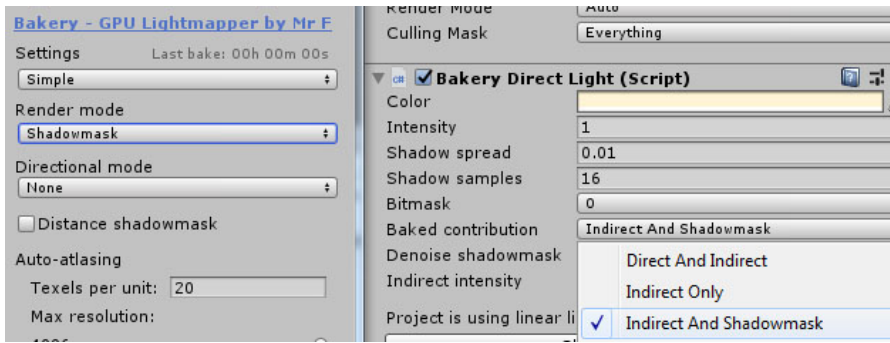
### Shadowmask

A more advanced mixed mode. It works by generating two types of lightmaps - one with baked color (as in Indirect mode), and another with shadows from static objects. It has several benefits:

- Real-time shadows can render only a handful of dynamic objects, instead of the whole scene.
- Real-time and baked shadows blend together properly.
- Real-time lights can render bump, specular and other surface effects, while still being occluded by high-quality baked shadows.

More details (<https://docs.unity3d.com/Manual/LightMode-Mixed-Shadowmask.html>)

Currently only Direct, Point and Spot lights can interact with shadowmasking (because they are the only types Unity supports in real-time). To enable this behaviour, you must have both Unity and Bakery lights on the same object, with Baked Contribution set to *Indirect and Shadowmask*. Unmarked lights will be baked as in Indirect mode.

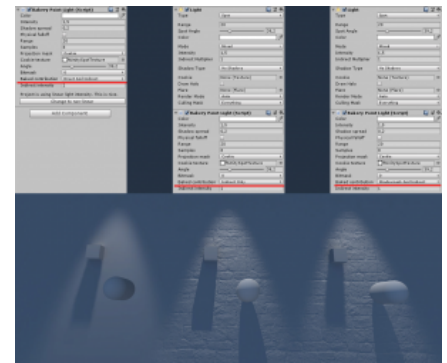


### Distance Shadowmask

This checkbox is only visible if you chose shadowmask and simply toggles equally named setting (<https://docs.unity3d.com/Manual/LightMode-Mixed-ShadowmaskMode.html>) in project's Quality Settings. More details. (<https://docs.unity3d.com/Manual/LightMode-Mixed-DistanceShadowmask.html>)

💡 Checkbox is not visible on Unity 5.6.x due to the lack of corresponding scripting API. Instead you can toggle it in Window->Lighting->Mixed Lighting->Lighting Mode.

💡 On Unity versions < 2017.3 rendering Shadowmask lightmaps will clear the light probes due to API limitations. They will need to be re-rendered again after bake. It shouldn't happen on newer versions.



Left: completely baked light. Center: dynamic light with baked GI. Right: capsule shadow, bump and specular are dynamic, but cube shadow and GI are baked.



When camera gets far away enough or if dynamic shadows are disabled, the same scene will look like this

### Subtractive

Enables Subtractive (<https://docs.unity3d.com/Manual/LightMode-Mixed-Subtractive.html>) lighting mode.

This option does not do anything special to lightmaps and, in fact, works just like Full Lighting.

The only difference is that it also sets up real-time Unity lights to work with Subtractive mode (as it cannot be done through UI).

You will need to additionally set up global subtractive parameters (like the global shadow color) in Unity lighting window (<https://docs.unity3d.com/Manual/GlobalIllumination.html#MixedLighting>).

### Ambient Occlusion Only

Only bakes AO. May be useful if you know what you're doing. Make sure to set up AO options.

## Directional mode

Defines how directional information is baked. Standard lightmaps only store a single color per texel, while directional lightmaps give shaders a hint of how lighting changes over a hemisphere around the texel. This data is required to combine fully lightmapped areas with normal maps. Plugging it into the built-in Bakery shader can also produce approximate specular response.

### None

No directional data, single color per texel.

### Baked Normal Maps

Still no directional data, but normal maps are taken into account when rendering the lightmap. There is no additional runtime overhead. Since lightmaps usually have lower resolution than normal maps, the result may look blurry. Other problems include aliasing at distance due to lack of mipmapping and denoising step potentially smudging the detail. To learn how to use custom shaders with procedural normals in this mode, read Normal Mapping section.

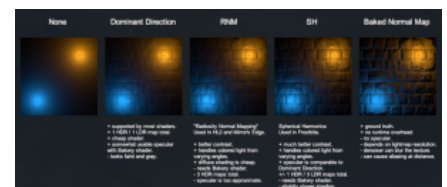
### Dominant Direction

This mode is similar to what Enlighten and Progressive bake in Unity. It is compatible with most shaders, only generates one additional map and the runtime overhead is minimal. The downside is that bump-mapping looks rather faint and gray-ish and can be quite different comparing to the same object under real-time lighting.

### RNM

Based on Radiosity Normal Mapping technique originally invented for HL2 (slides ([https://steamcdn-a.akamaihd.net/apps/valve/2004/GDC2004\\_Half-Life2\\_Shading.pdf](https://steamcdn-a.akamaihd.net/apps/valve/2004/GDC2004_Half-Life2_Shading.pdf))) and later used in many games (e.g. Mirror's Edge). It generates 3 HDR maps in total, being the most memory-demanding mode of all. Runtime overhead is still relatively low. This mode is more precise than Dominant Direction. It is better at reproducing surface contrast and handling colored lights affecting normal maps from different angles.

### SH



Comparison of different directional modes



Based on "Precomputed Global Illumination in Frostbite" paper (<https://media.contentapi.ea.com/content/dam/eacom/frostbite/files/gdc2018-precomputedglobalilluminationinfrostbite.pdf>). This is the highest quality mode, giving much better surface contrast and representing differently colored lighting coming from different directions. Generates 4 maps in total, only one of them being HDR, therefore takes less memory than RNM. Runtime overhead is slightly higher than that of RNM.

### Limitations

- RNM and SH can be only used with Bakery shader or require adjustments to your shaders.
- In RNM and SH modes, standard color lightmaps are not created. You need to either have Bakery shader on all materials in the scene, or use [Lightmap Groups](#) to separate RNM/SH objects from the rest.
- RNM and SH maps are applied to objects using [MaterialPropertyBlock](https://docs.unity3d.com/ScriptReference/MaterialPropertyBlock.html) (<https://docs.unity3d.com/ScriptReference/MaterialPropertyBlock.html>) and so may be not shown completely in Unity's Lighting window.
- Dominant Direction, RNM and SH modes may require slightly more samples for GI and Light Meshes to get comparable quality.

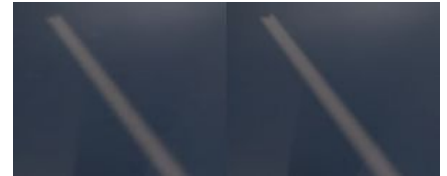
### Texels per unit

Approximate amount of lightmap texels per world unit. Affects the amount and resolution of generated lightmaps.

Example values to get you started:

- Large outdoor area (a city): 1 - 5
- Medium outdoor area (a few alleys): 10-20
- High quality interior: 100

Keep in mind that Texels Per Unit is base resolution, but every object can be additionally tweaked using [Scale](#) in [Lightmap](#) (<https://docs.unity3d.com/Manual/class-MeshRenderer.html>) option on Mesh Renderers as well as [Scale per map type](#) in Bakery window.



1 vs 10 texels per unit



Objects with Scale in Lightmap set to 0 will not be baked, but will still cast shadows and affect GI.

### Max resolution

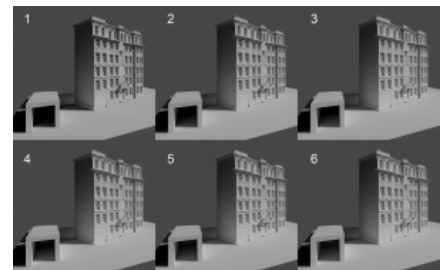
Maximum lightmap size limit. If objects can't fit in a single lightmap (given current Texels Per Unit value), additional lightmaps will be allocated. Same 4 square objects can take four 512x512 maps or one 1024x1024.

### Bounces

Defines how many times light rays should bounce off surfaces. Usually lower values are sufficient for outdoor scenes (e.g. a city), while higher values are required for more closed scenes (interiors, caves).

### Samples

Affects quality of GI. Typical values are from 16 to 32.



Note how more bounces bring more light to closed spaces.

### GPU Priority

While GPU is working on lightmaps, OS and other software may become less responsive. This option allows you to balance between baking speed and system responsiveness.

### Render

Bakes lightmaps for all opened scenes.

### Render Light Probes

Bakes [light probes](#) (<https://docs.unity3d.com/Manual/LightProbes.html>) for all opened scenes.

Note that to get correct mixed light shadowing on dynamic objects in Shadowmask mode you also need to enable [occlusion probes](#).



Left: samples = 4, right: sample = 16. Denoising is off for illustrative purposes.

### Render Reflection Probes

Bakes [reflection probes](#) (<https://docs.unity3d.com/Manual/class-ReflectionProbe.html>) for all opened scenes. This button is just for convenience and will call built-in engine reflection probe update.

### Update Skybox Probe

Bakes global diffuse and reflection probe for the current skybox. As with "Render Reflection Probes", it just calls built-in engine functions.

## Occlusion probes

When "Render Light Probes" is pressed, lets Unity bake occlusion probes using currently selected built-in lightmapper. Occlusion probes is additional data stored inside regular light probes, and it prevents dynamic objects from getting lit in shadowed areas. Currently there is no way to use custom occlusion probes in Unity, and it has to call its own lightmappers instead to do the job.

## Warnings

These options will validate the scene after one of the Render buttons is pressed and show warning dialog boxes asking to continue or stop the baking process.

- UV validation: will check if all models have fully correct lightmapping UVs - specifically if they lie within 0-1 range and don't overlap.
- Overwrite check: will tell which lightmap files are going to be overwritten.
- Memory check: will tell a very approximate amount of video memory required.
- Sample count check: will check if any lights, GI or AO have unreasonable sample counts that can make GPU go out of available resources.
- Lightmapped prefab validation: validates Lightmapped Prefabs and notifies if some prefabs are going to be overwritten.

## Advanced render settings

### Light probe mode

Changes the way light probes are baked.

- Legacy: use Render Light Probes button to generate the probes. Point and directional lights are calculated within the lightmapper, while area/sky/indirect lighting is gathered by rendering a cubemap at each probe position. Results are stored as L2 spherical harmonics (<https://docs.unity3d.com/ScriptReference/Rendering.SphericalHarmonicsL2.html>). The downsides are slow cubemap rendering performance and possible mismatch between lightmaps and probes in cases where shaders in your game do not physically represent lit surfaces or your project is set up for mobile (Unity can clip high intensity values away).
- L1: light probes will be rendered together with lightmaps when you click Render. This option provides superior baking performance and will guarantee that probe lighting matches the lightmaps. Results are stored as L1 spherical harmonics (can be still used by regular shaders). Results can be further improved by using Non-Linear Light Probe SH option in Bakery shader.

L1 probes are not recommended for Full Lighting bakes, especially in high-contrast HDR scenes, but they are quite sufficient when used for indirect lighting.

### Asset UV Processing

Configures UV padding adjustment for assets. Possible values:

- Don't change: don't touch the assets.
- Adjust UV padding: will look for models with auto-generated UVs ("Generate Lightmap UVs" on the asset) and adjust them further to have proper padding between UV islands per-mesh. Model-wide Pack Margin in importer settings is ignored. Optimal values are calculated instead, given area of each mesh and lightmap resolution.
- Remove UV adjustments: reverts all previous UV adjustments, makes auto-unwrapped models look they way Unity originally unwrapped them.

### Adjust sample positions

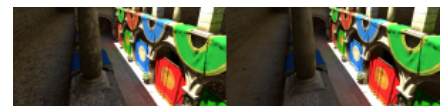
Find best sample positions to prevent lighting leaks. Details of the algorithm are outlined here (<https://ndotl.wordpress.com/2018/08/29/baking-artifact-free-lightmap-s/#leaks>). In some cases (usually large and very low poly geometry with smooth normals) it may produce incorrect results, in which case you can disable it.

### Unload scenes before render

Unloads Unity scenes before baking to free up video memory. Complex scenes can take a few gigabytes of VRAM by simply being shown in editor.

### Denoise

If enabled, will apply denoising algorithm. Bakery uses Nvidia's AI denoiser (<https://developer.nvidia.com/optix-denoiser>).



Left: denoising off, right: denoising on.

### Fix Seams

If enabled, will attempt to blend seams created by UV discontinuities. Useful for smooth geometry, including Unity's default sphere.

### Split by scene

If multiple scenes are loaded at once, and this option is enabled, each scene will have its own set of lightmaps, not shared with others. It can be useful for limiting the amount of textures loaded when scenes are streamed at runtime.

### Hole filling



If Atlas Packer is set to xatlas, will try to fill every hole, resulting in more efficient atlases. For scenes with very complex geometry it can increase scene export time, but otherwise recommended.

## Min resolution

Minimum lightmap size limit. Can be used to balance between many small but fully occupied lightmaps vs few incompletely filled.

## Scale per map type

Allows you to scale the resolution of color/shadowmask/direction maps differently. For example, a common case would be to have low resolution indirect color but highly detailed shadowmask. Note that scaling is applied after the lightmaps are rendered, so it won't save baking time. If "Adjust UV padding" is on, padding will be based on the lowest resolution map to prevent texel leaking.

## Checker preview

If Show checker checkbox is on, Scene View will render a checkerboard pattern on top of visible objects to demonstrate lightmap texel size. This is useful to make sure you are using adequate values for Texels Per Unit and other resolution-affecting settings before you bake.

Enabling checker preview will force Bakery to perform atlas packing. It can take some time, but shouldn't be longer than a few seconds. Press Refresh checker to re-atlas the scene after you changed something to see changes.

Checker preview also uses random colors to show how the scene will be split into different lightmaps.



Checker preview currently does not show correct texel sizes for Terrains.

## Emissive boost

Multiplies any surface emission by this number.

## Indirect boost

Multiplies all bounced lighting by this number. Same as Indirect Intensity on light components, but global.

## Backface GI

Determines how much light is passed through front faces to back faces and then bounced off by GI. This is especially useful for thin translucent surfaces like leaves. Values are in 0-1 range.

## Ambient occlusion

Simple non-physical ambient occlusion you can apply over final scene lighting for aesthetic purposes.

- Intensity: controls visibility of the AO effect. Value of 0 disables the effect.
- Radius: determines the ray distance used in the AO effect. Smaller values give localized occlusion (corners, wrinkles), while larger values make it more similar to Skylight, giving shadows from distant objects.
- Samples: affects the quality of ambient occlusion. Typical values are from 4 to 32.

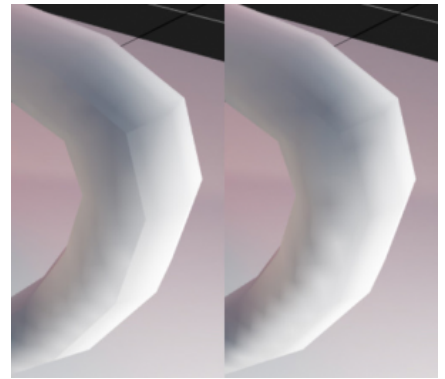
## RTX Mode

Enables RTX hardware acceleration. Only RTX GPUs will benefit from this option. Minimum supported driver version is 418.

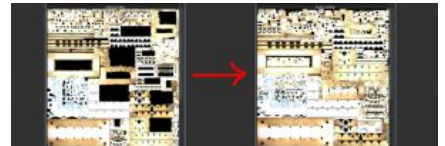
Drivers can emulate RTX mode on most non-RTX Nvidia cards, but the result is usually slower.

## Export terrain trees

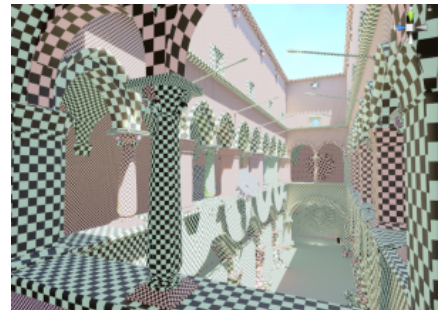
If enabled, painted terrain trees will affect lighting. Trees themselves will not be baked. Note that highest possible LOD level is used for every tree during baking. It is not recommended to use this option for rendering multi-kilometer forests with highly detailed models.



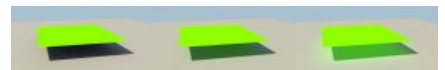
Left: seams, right: seams are fixed.



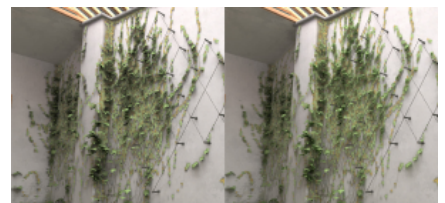
Hole filling off vs on.



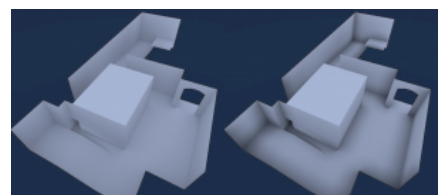
Checker preview in action



Backface GI



Left: backface GI = 0, right: backface GI = 1. Note how shadowed areas receive more green lighting.



Left: AO intensity = 0. Right: AO intensity = 1.

## Terrain optimization

If enabled (default), Terrains use separate ray tracing technique to take advantage of their heightfield geometry. Otherwise they are treated like any other mesh. Terrain optimization significantly reduces memory footprint required for high-resolution landscapes. In some cases it can also make terrain baking faster, in other cases (especially with simple low-resolution landscapes) it might make sense to disable it.

---

## Samples multiplier

Multiplies all shadow and GI samples by the specified factor. Use it to quickly change between draft and final quality.

---

## GI VRAM optimization

Toggles memory optimization used for very large scenes, especially when baking too many lightmaps at once. If enabled, may slow down rendering a little bit. If disabled, and the scene is too big, Bakery may go out of memory.

- Auto: guess if optimization is needed based on open scenes. The guess is only approximate, so if you know the scene is huge, set it to Force On.
  - Force On: always enabled.
  - Force Off: always disabled.
- 

## Tile size

Same as [GPU Priority](#), but instead of abstract priority you set tile size. Bakery splits lightmaps into smaller tiles and updates one at a time. Smaller size means more GPU work interruptions, and can make system more responsive.

---

## Temp path

Temporary files folder. Bakery may require a few gigabytes of free space during rendering. Having this folder on SSD can make rendering slightly faster comparing to HDD. At the moment, this folder is not cleaned automatically. You can delete its contents anytime (except during rendering).

---

## Output path

Lightmap folder. This is where all lightmap, and also lightprobe and vertex color assets will be saved. This path is relative to your Assets folder.

---

## Use scene named output path

If this option is enabled, output path will be automatically set to a folder with the same name as the currently active scene (Assets/CurrentSceneName/). This is similar to how built-in Unity lightmappers behave.

---

## Render Selected Groups

Only bakes [Lightmap Groups](#) containing selected objects. Not only selected objects will be redrawn, but all Lightmap Groups they belong to. Other lightmaps will not be updated. If objects are not a part of some manually assigned group, then a part of the scene using the same lightmap will be rebaked.

---

## Beep on finish

If enabled, Bakery will play a sound when the bake is finished.

# Experimental render settings

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## Unwrapper

If [Adjust UV Padding](#) is enabled, defines the unwrapper that will be used.

- Default: standard Unity unwrapper. Bakery will call `Unwrapping.GenerateSecondaryUVSet` (<https://docs.unity3d.com/ScriptReference/Unwrapping.GenerateSecondaryUVSet.html>) for every mesh with different padding parameters.
  - xatlas: uses `xatlas` (<https://github.com/jpcy/xatlas>) by `jpcy` (<https://github.com/jpcy>), a modified version of `thekla_atlas` ([https://github.com/Thekla/thekla\\_atlas](https://github.com/Thekla/thekla_atlas)) by Ignacio Castaño (<https://github.com/castano>). `thekla_atlas` was used in The Witness ([blog post \(http://the-witness.net/news/2010/03/graphics-tech-texture-parameterization/\)](http://the-witness.net/news/2010/03/graphics-tech-texture-parameterization/)).
- 

## Atlas Packer

Selects the algorithm to use when packing different object UV layouts into large lightmap atlases.

- Default: original algorithm Bakery used before v1.7.
- xatlas: uses `xatlas`.

Some features are only supported with one atlas packer:

	Default	xatlas
Override resolution	Yes	No
Efficient LOD packing	No	Yes
Hole filling	No	Yes

Note that atlas packer can be also chosen separately for every Lightmap Group.

---

## Export geometry and maps

If enabled, Bakery will export the scene to its format before rendering. If you are sure that geometry and textures of the scene and lightmap resolution settings were not changed (e.g. you are only tweaking GI or light settings), you can disable this checkbox to make next rendering faster.

---

## Update unmodified lights

If enabled, Bakery will recalculate light sources that didn't change since last rendering. If you are only tweaking one light and don't want to wait for other lights to re-render, you can disable this checkbox.

---

## Update modified lights and GI

If enabled, Bakery will recalculate GI and lights that were changed since last rendering.

---

## UV padding: increase only

Only visible if [Adjust UV padding](#) is on. By default, optimal UV padding for a model asset is calculated only based on currently loaded scenes. If there are multiple instances of the same model using different lightmap resolution, the smallest one will define padding, so spacing between UV charts is large enough to prevent them from leaking over each other. However, baking the same model in 2 different isolated scenes will possibly break UVs in previous scenes while optimizing for the new one. This checkbox allows to prevent such behaviour by never decreasing the padding value, so it will be always optimized for the lowest resolution instance ever baked.

---

## Denoise: fix bright edges

Only visible if [Denoise](#) is on. Sometimes the neural net used for denoising may produce bright edges around shadows, like if a sharpening effect was applied. If this option is enabled, Bakery will try to filter them away. Denoising stage may get slightly slower, when enabled.

---

## Legacy denoiser

Uses a non-RTX version of the denoiser (based on OptiX 5.1 instead of 6.0). Try this if denoising fails and you are using a Kepler GPU (GeForce 6xx).

---



Left: a bright edge is visible after denoising; Right: fixed.

## Combine with Enlighten real-time GI

If enabled, then when the Render button is pressed, it will first try to bake with Enlighten to calculate real-time GI. After that, regular Bakery lightmapping process will happen. Both baked and real-time GI will work together.

---

## Bake on remote server

Enables [network baking](#).

---

# Components

---

## Bakery Lightmap Group Selector

Specifies which **Lightmap Group** to use for the object and all of its children. Lightmap Group is a term Bakery uses for a collection of objects sharing one lightmap. Groups have properties telling Bakery how to pack the objects, which lights should affect them, should the result be baked into a texture or vertices. By default all static objects are automatically packed into multiple lightmaps groups (atlases), so you don't have to worry. Defining groups manually should be only used for special purposes, for example:

- Marking certain objects use [per-vertex lightmap](#) instead of textures.
- Baking a lightmap using exact unscaled UVs as they were in a modeling package.
- Grouping certain areas of the level to use single lightmap to facilitate resource streaming or to switch different baked lighting at runtime via scripts.
- Using Render Selected button to only update grouped objects.

To manually define a group, you create **Lightmap Group Assets**, either by using Assets->Create menu, or using the Create New button in the component. When using the Create New button, new asset will be created based on these forms:

- Name: name of the Lightmap Group Asset to create.

- Packing mode: this selector defines the packing mode of the Lightmap Group. There are 3 modes:
  - Original UV: object and its children will be baked with unmodified UVs. No packing is performed. This is useful for models when multiple meshes share the same already packed UV layout.
  - Pack Atlas: object and its children are packed into a dedicated texture atlas. Before v1.3 every packable child needed to have the component, but it's no longer necessary. Every child will be packed as its own rectangle, except when Bakery auto-detects a child having non-overlapping sub-children, in which case multiple objects can use a single rectangle.
  - Vertex: object and its children will use vertex-colored baked lighting instead of textures. Note that you'll need a custom shader for this to work, like Bakery Shader. One simple shader ("Bakery/Simple Vertex Lightmapped") is also included for demonstration and reference. [Learn more about vertex lightmaps.](#)
- Directional mode: allows you to override [directional mode](#) on the group. Options are the same except for Auto, which will simply use the global setting.
- Resolution: desired lightmap resolution.
- Atlas packer: select atlas packing algorithm for this group.
- Bitmask: a list of toggles used to exclude light sources from affecting the lightmap. Every Bakery light source also has a bitmask setting. Lights only affects Lightmap Groups with which they share at least one of these toggles. Default settings mean all lights affect all lightmaps.

If you have a Lightmap Group with the Pack Atlas mode assigned, additional settings will appear on the component:

- Override resolution: override the resolution this object and its children occupy in the lightmap.
- Resolution: manually defined resolution. For example, if you have a lightmap with a resolution of 512 and it is assigned to 4 objects with override resolution set to 256, Bakery will generate a single 512x512 lightmap where each object takes exactly 256x256 square.

If you select a Lightmap Group asset, additional experimental settings will be visible:

- Subsurface scattering: ([click to read more](#))
- Normal offset: allows you to offset rays from the surface. This is rarely useful and mostly present for experimental purposes.
- Transparent selfshadow: start rays behind the surface so it doesn't cast shadows on self. Might be useful for translucent foliage.



Transparent selfshadow OFF vs ON: note how some single-sided but back-facing polygons become properly lit

## Bakery Lightmapped Prefab

This component allows prefabs to store lightmapping metadata. Such prefabs can be then instantiated in any scene, both in editor and at runtime. The component should be added directly to the root object of the prefab. Nested prefabs are not supported. Because the prefab is going to be overwritten after bake (the same way as when the "Apply" button is pressed), it is required that the prefab does not have any unapplied changes (child objects shouldn't be moved, materials and script parameters should be unchanged, etc). If such changes are detected, an error will be printed in the component UI and no metadata will be saved after bake. If [Lightmapped prefab validation](#) warning is enabled, all prefab errors will be also shown in a dialog box before the bake.

Lightmapped prefabs support all Bakery features, such as LODs, terrains, directional lightmaps, RNM, SH, per-vertex modes and shadowmasks. For shadowmasks to work, you need lights to also be a part of the same prefab.



Note that prefab shadowmasks only work on Unity 2017.4 or newer due to API limitations.

After baking, an object named "BakeryPrefabLightmapData" will be added to prefab. This object holds a script with all necessary data to apply the lightmaps.

Additionally, Lightmapped Prefab allows to save current render settings and load them back to any currently open scene, using two buttons:

- Save current render settings to prefab: stores a copy of current Render Settings on this prefab.
- Load render settings from prefab: sets current Render Settings to those stored on the prefab.

## Bakery Direct Light

Infinitely distant directional light (e.g. Sun).

- Color: color.
- Intensity: linear color multiplier.
- Shadow spread: size of the light source or, simply put, shadow blurriness. 0 = max sharp shadows, 1 = max blurred shadows. Technically it interpolates from a single ray to a wider cone of rays.
- Shadow samples: affect shadows quality. The smaller the Shadow Spread value, the less samples are needed for a clean image. Typical values for sun shadows are from 1 to 16. Setting samples to 0 will make shadows from this light disappear.
- Bitmask: a list of toggles used to exclude this light source from affecting particular Lightmap Groups.
- Baked contribution: determines what kind of lighting data should be baked. Only visible in Indirect or Shadowmask modes. Possible values:
  - Direct and Indirect: both direct and indirect contribution will be completely baked.
  - Indirect only: a realtime light is supposed to provide direct contribution; only indirect lighting is baked.
  - Indirect and Shadowmask: a realtime light is supposed to provide direct contribution, but shadows from static geometry will be baked to a separate map. Dynamic and static shadows will be mixed together. Indirect lighting will be baked as usual.
- Denoise shadowmask: determines if denoising should be applied to this light's shadowmask. Usually it's not necessary as shadows don't exhibit much noise, but can be useful for very wide blurry shadows (large shadow spread).
- Indirect intensity: non-physical GI multiplier for this light. Should be 1 for natural lighting, but can be modified for more stylized scenes.
- Texture projection: projects a multiplicative tiled texture over lighting. Can be used to emulate distant cloud shadows.



Pure direct light with GI



Left: shadow spread = 0.01, right: 0.05. Note how shadows start sharp and get gradually blurrier with distance.

If the same object has both Unity and Bakery light sources enabled, and they don't match, two buttons will appear:

- Match lightmapped to real-time: copy common settings from Unity light to Bakery light.
- Match real-time to lightmapped: copy common settings from Bakery light to Unity light.

## Bakery Sky Light

Infinitely distant shadowed ambient light (sky).

- Color: color.
- Intensity: linear color multiplier.
- Sky texture: optional cubemap asset, e.g. HDRI panorama to affect lighting colors from different directions.

💡 Rotating sky light's GameObject will rotate lighting from the cubemap accordingly.

- Samples: affects shadows quality. Typical values are from 8 to 32.
- Hemispherical: if enabled, lighting will only come from above (upper hemisphere). Otherwise from all directions.
- Bitmask: a list of toggles used to exclude this light source from affecting particular Lightmap Groups.
- Baked contribution: determines what kind of lighting data should be baked. Only visible in Indirect or Shadowmask modes. Possible values:
  - Direct and Indirect: both direct and indirect contribution will be completely baked. This is the default and recommended behaviour for all Sky Lights, as there is no real-time version to emulate them in Unity.
  - Indirect only: a realtime light is supposed to provide direct contribution; only indirect lighting is baked.

If sky light's settings and current scene skybox don't match, two buttons will appear:

- Match this light to scene skybox: copy common settings from active skybox material to Bakery sky light. Currently it can only match skyboxes using the "Skybox/Cubemap" or "Skybox/Bakery skybox" shaders.
- Match scene skybox to this light: copy common settings from Bakery sky light to scene skybox.



Pure sky light with GI

## Bakery Light Mesh

Emissive mesh of any shape. Should be used together with the Mesh Renderer component or with a Light component set to Area mode.

- Color: color
- Intensity: linear color multiplier.
- Cutoff: maximum lighting distance. Bakery will additionally attenuate correct inverse-squared falloff near the limit. It works best when cutoff value is just where physical falloff gets very dim. Cutoff can improve baking performance, but you also can set it to a very high (unreachable) value for complete correctness.
- Self Shadow: determines if light mesh itself casts shadows. This option also enables a more precise lighting algorithm.
- Samples Near: affect lighting quality near the mesh. Typical values are from 16 to 64. This option is only available when Self Shadow is on.
- Samples Far: affects lighting quality far away from the mesh. Typical values are from 4 to 4096.



Left: Samples Near = 0, Samples Far = 4096.  
Middle: Samples Near = 0, Samples Far = 128.  
Right: Samples Near = 16, Samples Far = 128.  
Note how the lighting appearance is similar, yet less combined samples are used.

Bakery mixes two different algorithms for area lights based on emissive surface proximity. Close to the light it works similar to the GI algorithm, while at a distance the light is approximated as a cloud of virtual point lights.

- 💡
- Light Meshes don't receive lighting on their own and don't get lightmapped.
  - One Light Mesh with many polygons is faster to bake than many simple Light Meshes.
  - If you keep getting dirty/noisy results, try setting Samples Near to 0. Then only the VPL algorithm is used. It is also useful for very simple lights where precision is not important (e.g. window lights on a building).

- Bitmask: a list of toggles used to exclude this light source from affecting particular Lightmap Groups.
- Baked contribution: determines what kind of lighting data should be baked. Only visible in Indirect or Shadowmask modes. Possible values:
  - Direct and Indirect: both direct and indirect contribution will be completely baked. This is the default and recommended behaviour for all Light Meshes, as there is no real-time version to emulate them in Unity.
  - Indirect only: a realtime light is supposed to provide direct contribution; only indirect lighting is baked.
- Indirect intensity: non-physical GI multiplier for this light. Should be 1 for natural lighting, but can be modified for more stylized scenes.

If mesh material and light settings do not match, two buttons will appear:

- Match light to material: copy common settings from unlit mesh material or area light to Bakery light.
- Match material to light: copy common settings from Bakery light to unlit mesh material or area light.

### Differences between Light Mesh and emissive materials

Emissive material:

- Propagates light during GI calculation, therefore is "free", no matter how many meshes are emissive.
- Small and bright lights can give inaccurate noisy results, depending on GI sample count.
- Has to occupy space in lightmap due to the way GI in Bakery works, therefore possibly wasting it. Also it means that emissive objects require valid UVs and have "Cast shadows" enabled..

Light Mesh:

- Lighting is calculated separately for each light, therefore is slower than emissive materials.
- Designed to give clean results for small and bright lights, even very far away from them.
- Doesn't take space in lightmaps.



A curved Light Mesh



## Bakery Point Light

Point light, doesn't have area. Despite physical impossibility it is useful for games and the only way to match Unity's point and spot lights.



Left: Shadow Spread = 0.5, right: Shadow Spread = 1.

💡 Spot lights are just point lights with additional projection mask.

- Color: color.
- Intensity: linear color multiplier.
- Shadow spread: shadow blurriness. Although point lights don't have area, it is often desired to still have blurred shadows from them. For this purpose shadows are simulated as if they were cast from a spherical area light. This parameter defines the radius of such virtual sphere, directly affecting blurriness.
- Physical falloff: if enabled, will use correct inverse-squared falloff with additional attenuation near the limit. Otherwise will try to mimic Unity's falloff.
- Falloff min size: learn more in [Point Light Attenuation](#) section.
- Range: if physical falloff is disabled, equals to Unity's light range. If it's enabled, will only slightly fade away physical falloff at the edge.
- Samples: affects shadows quality. Typical values are from 1 to 512. Setting samples to 0 will make shadows from this light disappear.
- Projection mask: type of mask/cookie. Options:
  - Omni: no mask, equals to Unity's Point Light.
  - Cookie: cookie texture projection. Additional options:
    - Cookie texture: 2D texture asset. Bakery includes the original Unity's Spot Light texture (named `ftUnitySpotTexture`) that you can use to mimic it.
    - Angle: texture projection angle (similar to Unity's Spot Light).
  - Cubemap: cubemap cookie projection. Additional options:
    - Projected cubemap: cubemap asset.
  - IES: lighting is modulated by the IES file data. Additional options:
    - IES file: file with `.ies` extension.
- Bitmask: a list of toggles used to exclude this light source from affecting particular Lightmap Groups.
- Baked contribution: determines what kind of lighting data should be baked. Only visible in Indirect or Shadowmask modes. Possible values:
  - Direct and Indirect: both direct and indirect contribution will be completely baked.
  - Indirect only: a realtime light is supposed to provide direct contribution; only indirect lighting is baked.
  - Indirect and Shadowmask: a realtime light is supposed to provide direct contribution, but shadows from static geometry will be baked to a separate map. Dynamic and static shadows will be mixed together. Indirect lighting will be baked as usual.
- Indirect intensity: non-physical GI multiplier for this light. Should be 1 for natural lighting, but can be modified for more stylized scenes.



Left to right: Omni, Cookie (default spot texture), Cubemap, IES.

If the same object has both Unity and Bakery light sources enabled, and they don't match, two buttons will appear:

- Match lightmapped to real-time: copy common settings from Unity light to Bakery light.
- Match real-time to lightmapped: copy common settings from Bakery light to Unity light.

## Bakery Always Render

If added to an object, Bakery will always take it into account when baking, even if its renderer is disabled.

## Bakery Pack As Single Square

If added to an object, Bakery will treat UVs of this object and its children as a single combined square and never move them away from each other during automatic atlas packing or in a Lightmap Group with Pack Atlas mode. Whole children hierarchy will be packed as one.

# Material compatibility

## Albedo and emission

Bakery supports most Unity materials by utilizing the [Meta Pass](https://docs.unity3d.com/Manual/MetaPass.html) system. All built-in, surface, LWRP and HDRP shaders already have a correct meta pass defined.

If you have an Unlit shader, add meta pass manually, as described in Unity docs.

If the pass is not present, Bakery will assume `_MainTex`, `_BaseColorMap` or `_Color` (if no texture is set) properties as material albedo and `_EmissionMap` and `_EmissionColor` as emissive color.

In order for emission to work, `Material.globalIlluminationFlags` (<https://docs.unity3d.com/ScriptReference/Material-globalIlluminationFlags.html>) must be set to `MaterialGlobalIlluminationFlags.BakedEmissive` (<https://docs.unity3d.com/ScriptReference/MaterialGlobalIlluminationFlags.BakedEmissive.html>). Standard shaders set this value automatically.

## Opacity

Currently Bakery always takes full resolution opacity from the alpha value of `_MainTex` or `_BaseColorMap` and treats it as cutout (1 bit transparency).

In order for opacity to work, `RenderType` tag (<https://docs.unity3d.com/Manual/SL-SubShaderTags.html>) of the shader must be one of these values:

- **Transparent**
- **TransparentCutout**




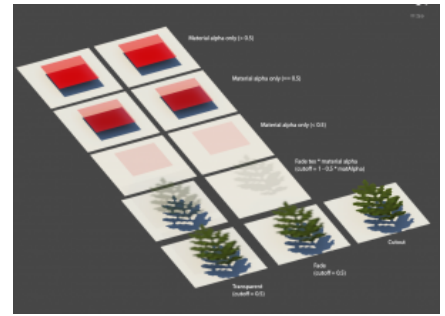
#### ▪ TreeLeaf

If a property named `_Cutoff` is present, it will affect the cutout (therefore Standard shader cutoff slider works automatically).

If material RenderType is **Transparent** or **TreeLeaf**, then alpha value of `_Color` will additionally modify the cutoff:  $finalCutoff = 1 - (1 - cutoff) * alpha$

For translucency effects read about [Backface GI](#) and [subsurface scattering](#).

 **Tip:** while Bakery does not support semi-transparent shadow casters at the moment, you can still take advantage of stochastic transparency, that is: use noise texture with different cutoff as alpha. Ray averaging and denoising will make it look semi-transparent. [Blue noise textures \(http://momentsingraphics.de/BlueNoise.html\)](http://momentsingraphics.de/BlueNoise.html) are recommended.



Material parameters converted to cutoff

## Normal mapping

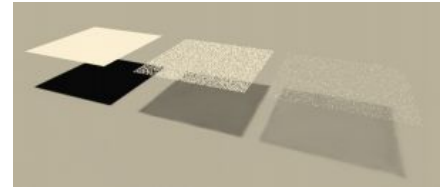
Custom surface normals can be used in conjunction with [Baked Normal Maps](#) mode. Unfortunately, Unity's Meta Pass does not output normal information, so by default normals are taken from a texture named `_BumpMap`, additionally transformed by `_MainTex_ST`.

It is however possible to make completely custom shaders with advanced normal mapping features (e.g. blending multiple layers) compatible with baking. To do that you'll need:

1. Define a Meta Pass in your shader, just as described in Unity docs (<https://docs.unity3d.com/Manual/MetaPass.html#ExampleMetaPass>).
2. Name it `"META_BAKERY"`, instead of just `"META"`.
3. Include `"BakeryMetaPass.cginc"`.
4. Add `#pragma vertex vert_bakerymt`
5. If `unity_MetaFragmentControl.z` variable is not 0, shader should return world-space normal. Returned normal should be encoded using `BakeryEncodeNormal` function.

Two example shaders implementing this extended Meta Pass are included in `Assets/Bakery/examples/shaders`.

You can copy and modify `BakeryMetaPass.cginc` to suit your needs, e.g. pass additional data from the vertex shader.



Using blue noise as alpha

# Skinned mesh renderer support

Bakery supports skinned meshes since v1.65. However, there are some limitations:

- Some versions of Unity do not support UV1 on skinned meshes and silently ignore "Generate lightmap UVs". Make sure the actual mesh used in your scene has UV1 and use non-overlapping UV0 if possible;
- UV padding adjustment does not work on skinned meshes (Unity seems to crash when attempting to call `Unwrap` function on them);
- Skinned meshes can't have per-vertex lightmaps (engine has no support for `additionalVertexStreams` with skinning).

## Shader Tweaks

Bakery offers optional shader modifications that can be applied to Unity shaders to improve lightmap sampling and match real-time lighting closer to lightmaps. Shader tweaking menu can be accessed via Bakery->Shader Tweaks.

These options will patch base Unity shader includes (from the `CGIncludes` folder) that are used by most built-in and third party shaders. All modifications will affect all projects opened with this version of editor, but can be also easily reverted back. Shader tweaks affect the way standard and surface shaders work. HDRP, LWRP and other SRPs are not affected.

All available modifications are shown as buttons. Press the button to apply modification, and it will remain pressed. Un-press the button to remove the modification. Currently available options:

 You may need to run Unity editor as admin to make `CGIncludes` patching work

- Use bicubic interpolation for lightmaps: bicubic interpolation will be used instead of default bilinear. This tweak fixes many jagged edges of low resolution lightmaps pretty well. Currently it only works on DX11 and modern consoles, while other platforms will remain using bilinear.
- Use multiplication for shadowmask: combine static and dynamic shadows using multiplication instead of minimum. For reasons unknown Unity decided to use minimum operator by default, and it produces artifacts that are not present with multiplication.
- Use physical light falloff (forward): replace default attenuation of real-time point/spot lights with a more physically correct inverse-squared. "Range" will only slightly fade it out near the edge (matches Bakery lights with Physical Falloff checkbox). Only affects forward renderer. See [Point Light Attenuation](#) for more details.



Left: default bilinear filtering. Right: bicubic filtering.



Left: both shadows are baked.  
Center: spherical shadow is dynamic, and other shadow is static. Combined together with multiplication.  
Right: same as center, but combined with default minimum.

- Use physical light falloff (deferred): same as above, but only affects deferred renderer.

# Bakery shaders

Bakery includes its own shaders with support for vertex lightmapping, as well as RNM and SH directional modes. It also allows approximate baked specular to be calculated from directional data. Bakery shader is **not required** for regular color lightmaps, shadow masks and Dominant Direction mode, as these features are supported by most Unity shaders anyway.

## Standard render pipeline

**Bakery/Standard:** extends regular Standard shader. Additional options:

- Allow Vertex Lightmaps: allows this material to be used with vertex lightmapping.
- Allow RNM Lightmaps: allows this material to be used with RNM directional mode.
- Allow SH Lightmaps: allows this material to be used with SH directional mode.

💡 All “Allow” toggles enable a certain code path in the shader. It is recommended to only use one “allow” option in a material for performance reasons.

- Enable Lightmap Specular: calculates baked specular using data from Dominant Direction, RNM or SH directional modes. Note that due to the lack of information, the effect is very approximate. If you ever used baked specular in Unity 4, it should be comparable. It looks best together with highly perturbed normal maps, not so good on flat surfaces.
- Enable VertexLM directional: if vertex lightmaps are present, specifies that Dominant Direction data is stored in vertices and should be used.
- Enable VertexLM SH: if vertex lightmaps are present, specifies that SH data is stored in vertices and should be used.
- Enable VertexLM Shadowmask: if vertex lightmaps are present, specifies that shadow mask is stored in vertices and should be used.
- Non-linear SH: in SH directional mode this option can enhance contrast (closer to ground truth), but it makes the shader a bit slower. This trick is based on “Reconstructing Diffuse Lighting from Spherical Harmonic Data” ([https://web.archive.org/web/20160313132301/http://www.geomerics.com/wp-content/uploads/2015/08/CEDEC\\_Geomerics\\_ReconstructingDiffuseLighting1.pdf](https://web.archive.org/web/20160313132301/http://www.geomerics.com/wp-content/uploads/2015/08/CEDEC_Geomerics_ReconstructingDiffuseLighting1.pdf)) paper by Geomerics.
- Non-linear Light Probe SH: similar to Non-linear SH, but works for light probes instead. In case of probes the most notable benefit is getting rid of incorrect negative values. This problem often happens in high-contrast scenes with bright HDR light sources. It's an inherent limitation of spherical harmonics and not specific to Bakery (i.e. you can get similar artifacts with built-in lightmappers as well).
- Force Bicubic Filter: enables bicubic filtering for all additional maps. For complete bicubic filtering (including the first color map) it is recommended to also enable it in Shader Tweaks.



Standard SH light probe vs non-linear

**Bakery/Standard Specular:** same as Standard, but for specular workflow.

## HDRP & URP

To extract additional HDRP/URP shaders, open Bakery\_ShaderGraphHDRP.unitypackage or Bakery\_ShaderGraphLWRP.unitypackage included with Bakery. Inside you will find Shader Subgraphs that you can use in your own Shader Graphs as well as some example materials.

## Feature support across shaders

	Most Unity shaders	HDRP & URP shaders	Bakery Standard	HDRP subgraphs	URP subgraphs
HDR color lightmaps	Yes	Yes	Yes	Yes	Yes
Shadowmask	Yes	Yes	Yes	Yes	No (URP does not support shadow masks)
Dominant Direction	Yes	Yes	Yes	Yes	Yes
RNM	No	No	Yes	Yes	Yes
SH	No	No	Yes	Yes	Yes
Lightmap specular	No	No	Yes	Yes for dominant direction and SH	No
Bicubic filtering	Yes, with <u>Shader Tweaks</u>	No	Yes, with <u>Shader Tweaks</u>	No	No
Vertex lightmaps	No	No	Yes	Single color, no per-vertex SH, direction or shadowmasks (shader graph limitation)	Single color, no per-vertex SH, direction or shadowmasks (shader graph limitation)
Non-Linear Light Probes	No	No	Yes	No	No

💡 Everything except for regular color lightmaps requires at least Shader Model 3.0 to work.

💡 Vertex Lightmaps with SH mode require at least Shader Model 4.0 due to interpolator limit.

## Upgrading Bakery

When it comes to upgrading the asset, it is recommended to follow these steps:

- Close Unity.
- Open it again.
- Import the updated package.

Note that without first closing Unity importing may fail because of locked DLL files.

## Scripting API

Get and modify render settings:

```
ftLightmapsStorage storage = ftRenderLightmap.FindRenderSettingsStorage();
```

Full list of available settings can be seen in `ftLightmapsStorage.cs`.

Get lightmapper instance and (re)load settings:

```
ftRenderLightmap bakery = ftRenderLightmap.instance != null ? ftRenderLightmap.instance : new  
ftRenderLightmap(); bakery.LoadRenderSettings();
```

Render lightmaps (also probes if they're set to L1 mode):

```
bakery.RenderButton(bool showMsgWindows)
```

Render light probes only:

```
bakery.RenderLightProbesButton(bool showMsgWindows)
```

Render reflection probes only:

```
bakery.RenderReflectionProbesButton(bool showMsgWindows)
```

**showMsgWindows** tells if any dialog boxes/confirmations can be shown. Supressed, if set to false.

Check if baking is in progress:

```
ftRenderLightmap.bakeInProgress
```

For usage example check [Batch Scene Baker](#) script.

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Retrieved from "<https://geom.io/bakery/wiki/index.php?title=Manual&oldid=802>"

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